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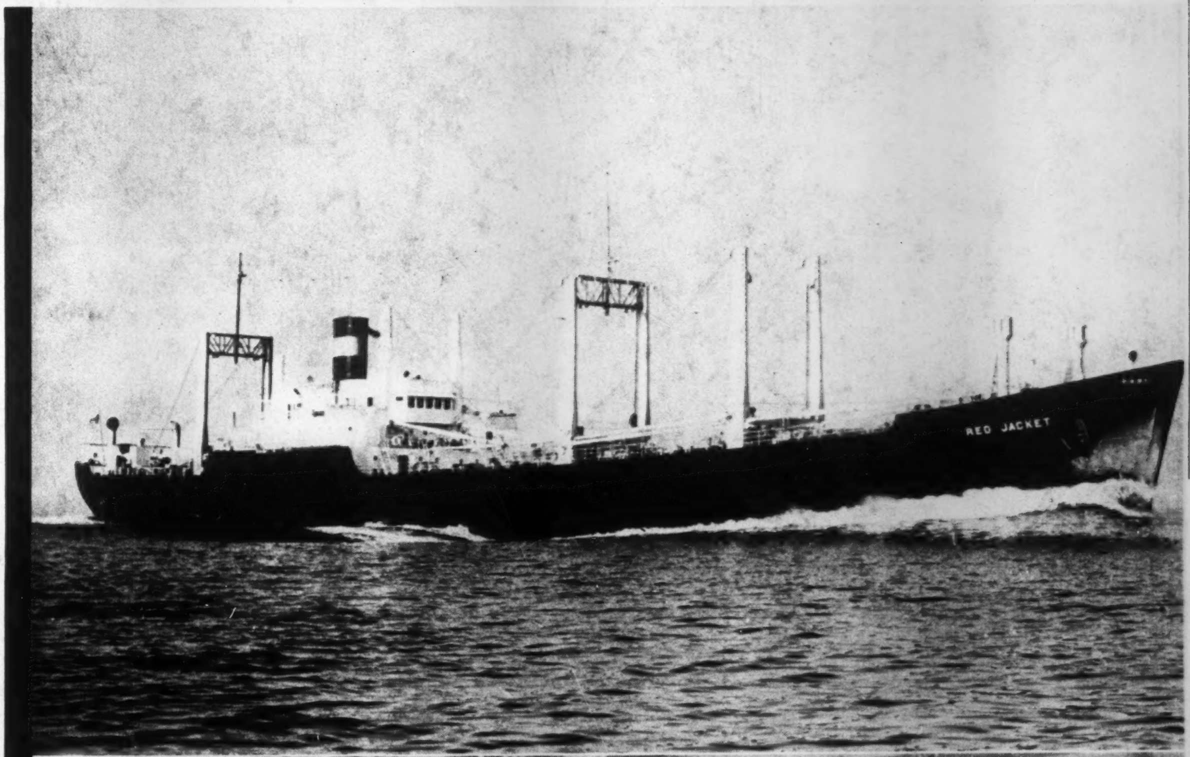

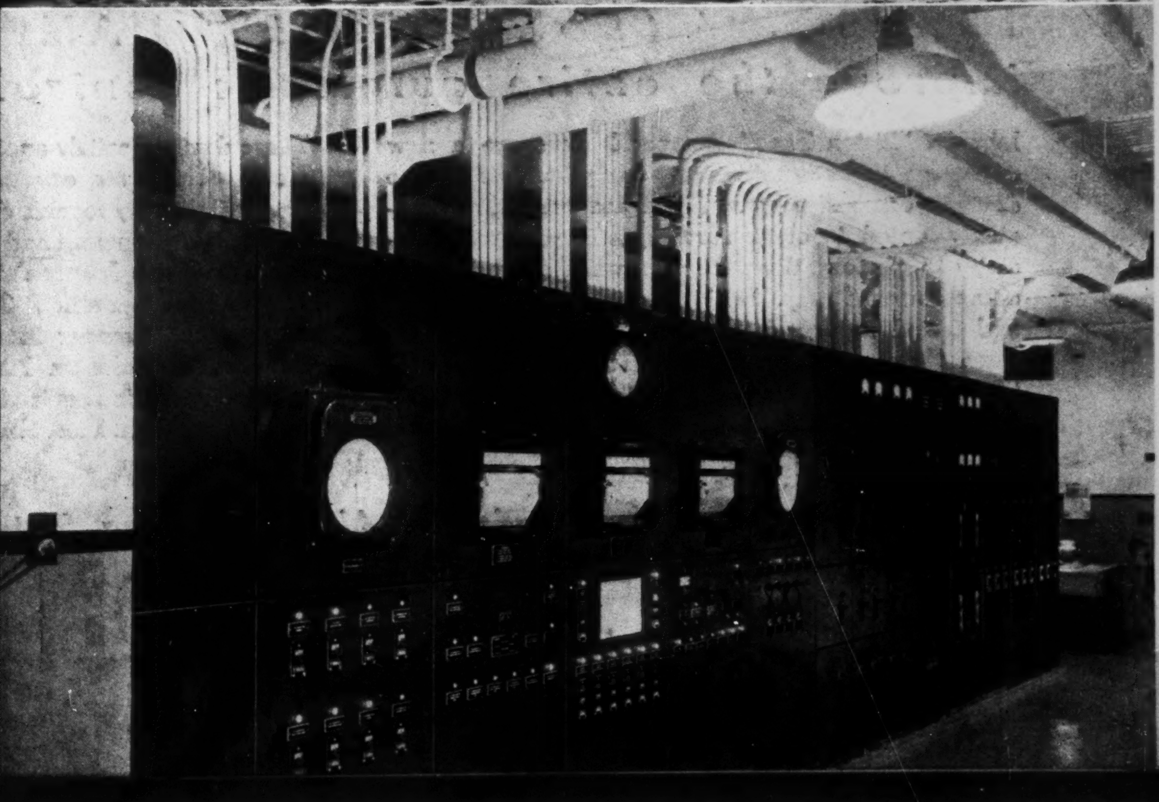

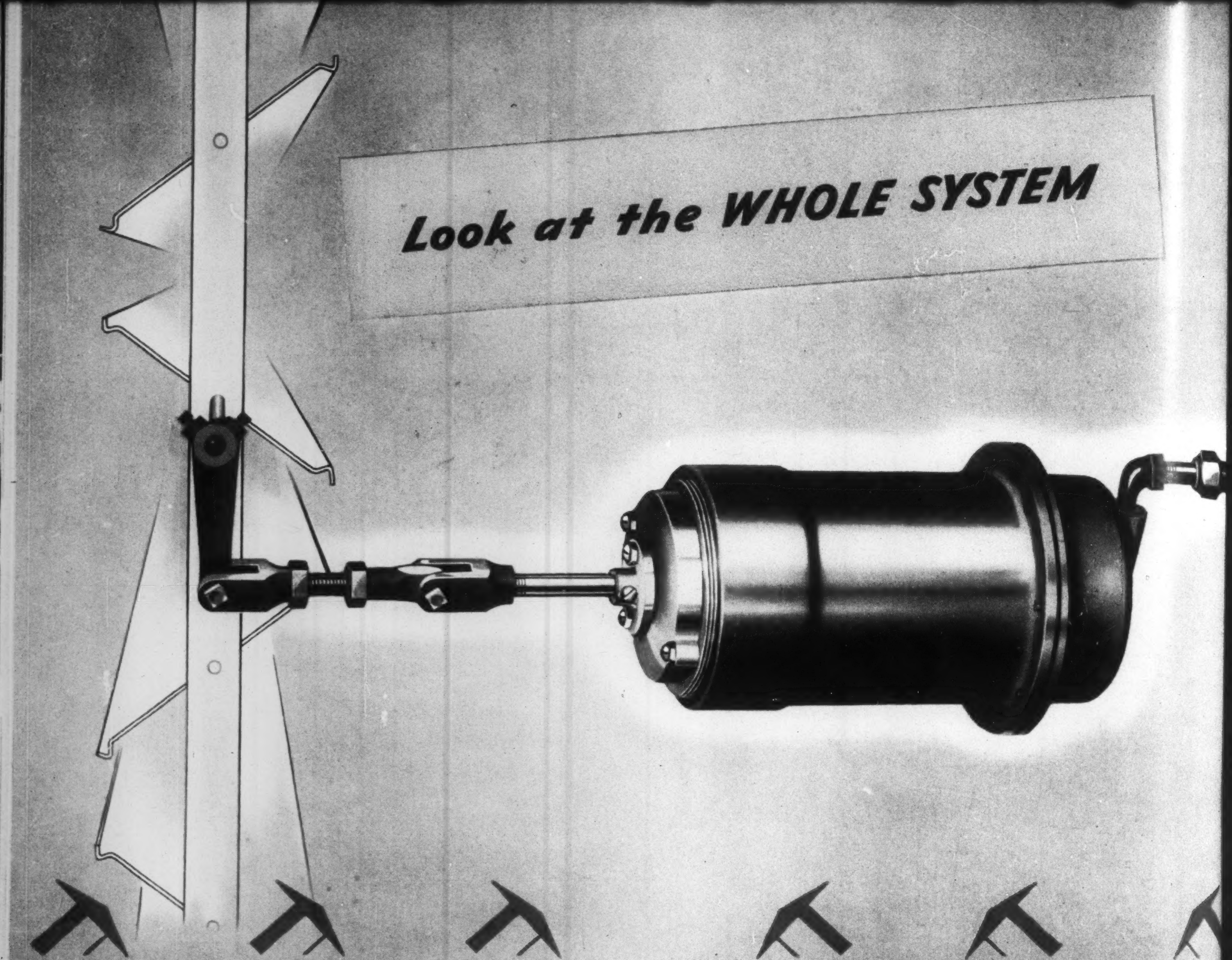

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Published monthly by the Keeney Publishing Company, 6 N. Michigan Ave., Chicago. Telephone: State 6916/ F. P. Keeney, President; W. J. Osborn, Vice-President; R. Payne Wettstein, Secretary; Chas. E. Price, Treasurer/ Address all correspondence to Chicago office/ New York office, Room 1734, Grand Central Terminal Bldg. Telephone: Murray Hill 9-8293/ Cleveland office, 2128 Rossmoor Road. Telephone: Yellowstone 1540/ Los Angeles office, 1406 S. Grand Ave. Telephone: Richmond 6191/ Subscriptions: U. S. and possessions, Canada, Mexico, Central America, South America, $2.00 per year; other, $4.00. Current copies, U. S. and possessions, 25c each, back copies 50c each. January, 1940, issue, $1.00 per copy/ Member of Audit Bureau of Circulations/ Member of The Associated Business Papers, Inc./ Copyright, 1940, by the Keeney Publishing Company

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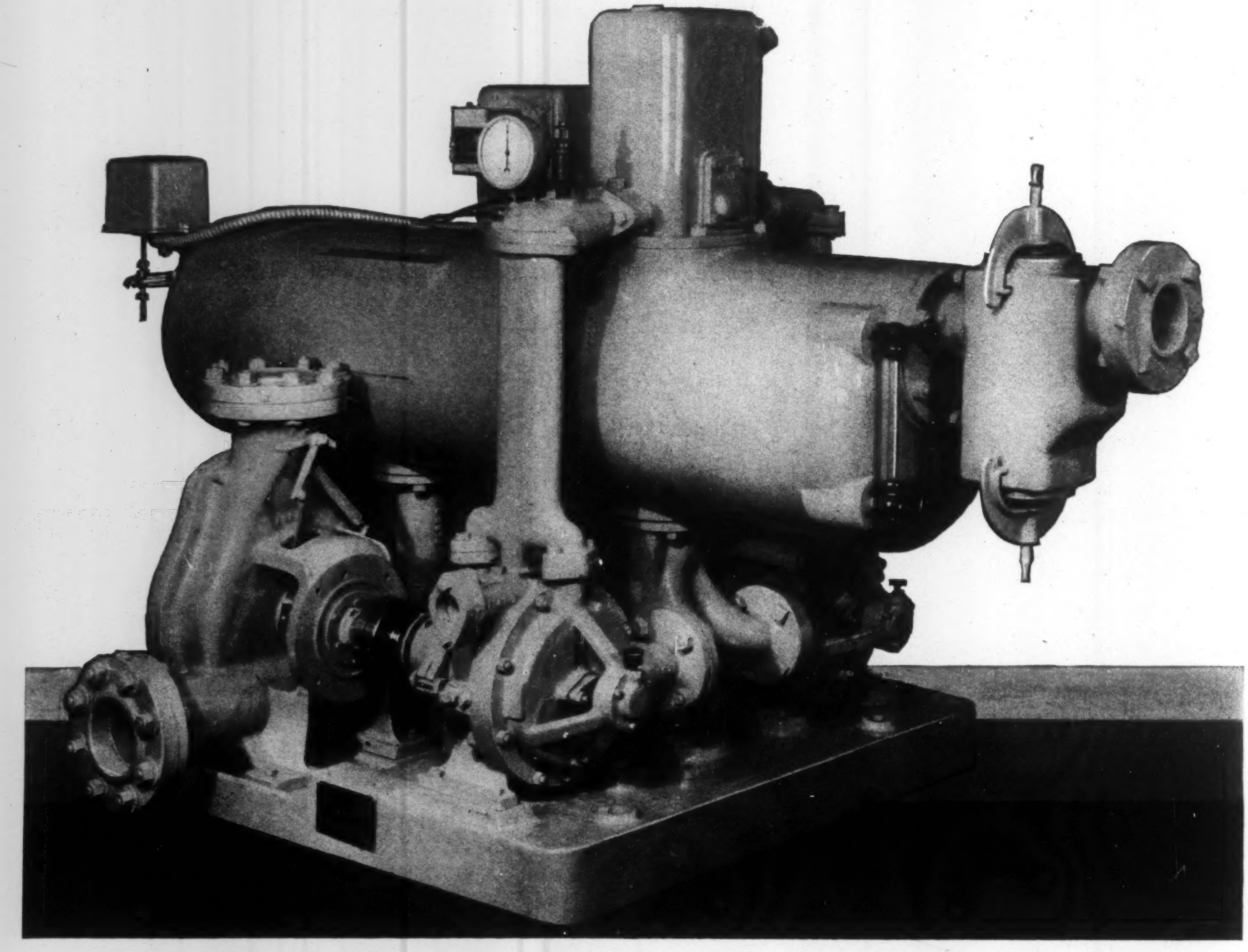
Where heat must *Not* fail . . . install this SAFE *Heating Pump*



In Hospitals, Greenhouses, Schools, Public Buildings, Theatres, wherever heating systems must not fail, install the Nash Vapor Turbine, for it is independent of electric current failure, and continues to operate as long as there is steam in the system. This is because the prime motive power of this economical pump is a special steam turbine, controlled by a unique "Vapor Turbine Valve", which automatically by-passes from the heating main a small portion of steam, the exact amount necessary to develop the power needed to remove the condensate and maintain the required vacuum on the system. Even this small amount is passed immediately back to the mains, and goes on to the system with little heat loss. This pump operates on any system, high or low pressure. The Vapor Turbine is a most economical pump, for the elimination of electric current does away with current cost, the largest single item in the operation of an ordinary return line heating pump.

BULLETIN ON REQUEST

THE NASH ENGINEERING COMPANY

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THE EDITOR'S PAGES

Heating, Piping and Air Conditioning Important Factors in National Defense

THE national preparedness and defense program is industry's most pressing problem, and efficient, up-to-date plant heating, piping and air conditioning services are important factors in its success. Therefore, we devote these columns this month to comments by recognized authorities and items on related questions.

E. P. Heckel, consulting engineer and member of HPAC's board of consulting and contributing editors—The subject of air conditioning as relating to the program for national preparedness and defense is not only timely but of greatest importance.

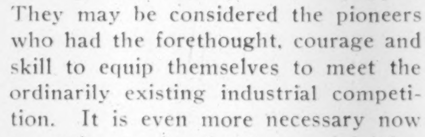
Industrially speaking, such a program covers a tremendous range of necessary step-up in activities and in manufacturing processes. Many engineering problems are involved in the processing of various materials before they are brought to a finished state. Processes which deal with materials hygroscopic in nature require a predetermined and fixed condition of air relative humidity to which the materials are subjected during the process to avoid changes in their characteristics which would be ruinous.

As applying to this class, various woods, fibers, textiles, cotton and certain explosives can be mentioned. There are others which are not susceptible to air relative humidity but are affected greatly by variations in air temperature during processing, which variations alter the precision of micrometer dimensions demanded for accuracy. In this class are the machining and finishing of metals, engine cylinders and parts, chronometers, gun barrels and functioning mechanism, machine tools, and in fact all precision instrument manufacturing.

There are a great many manufacturing processes that require, either directly or indirectly, some fixed and controlled condition of both temperature and relative humidity to assure and achieve the maximum of production and at the same time the optimum of precision and uniformity of quality of finished product. In this class we can place practically every manufacturing process for materials or chemicals the nature of which demands an air moisture content that is lower than that which normally would exist and hence requires dehumidification of air to a fixed dew point temperature. In such cases it is, of course, necessary to control both the air temperature and relative humidity in order to assure that the correct equilibrium can be maintained at all times. Gun powder, time fuse loading, star shells, gelatins, films, non-shatterable glass, optical glass, pharmaceuticals, printing, lithographing and the many more manufacturing processes that come within this category are too numerous to mention here.

Many of the existing manufacturers, having previously recognized the sound economical advantage and benefits of air conditioning to their processing, are already fully equipped. They may be considered the pioneers who had the forethought, courage and skill to equip themselves to meet the ordinarily existing industrial competition. It is even more necessary now to attain speed and step-up production without sacrificing high quality and uniformity.

It appears reasonable—judging by the various reports read in the periodicals and heard over the radio—that our security will be greatly enhanced once we are prepared to meet any possible aggressor. That means, obviously, that we must excel in our force of arms, aircraft, battleships and auxiliary vessels, munitions—all of which (now, more than ever before) require a vast amount of materials, instruments, chemicals, metals, rubber and fabrics, together with skilled artisans and workmen to provide the ever-increasing demand for the production of raw as well as finished and fabricated materials, the necessary instruments for our country's defense.



We must carefully and rapidly build to insure the adequate supply of what we need.

Included in this category of needs we must, of course, not overlook the building up of all our resources since practically every industry is in some form or other interwoven with the preparedness defense program. Farm products, meats and foods are of the utmost importance, hence their preservation by storage, under fixed temperature and humidity conditions to prevent spoilage, may require greatly expanded facilities to meet increasing demands.

Industry should and no doubt will "gear up to go" at a pace to fulfill every present as well as potential need.

* * *

Willis H. Carrier, chairman of the board, Carrier Corp.—Air conditioning will play an increasingly important part in the government's preparedness speed-up program, predicted Dr. Carrier at the first annual air conditioning institute held recently at the Massachusetts Institute of Technology.

Citing the case of American munitions plants during the last war, where humidity control in fuse loading assured perfect operation of time mechanisms on shells and bombs, Dr. Carrier contended air conditioning will prove a great help in controlling the accuracy and quality of other vital war devices and materials. Furthermore, air conditioning will make it possible and practical for large industrial plants to operate 24 hr a day, every day of the year, if necessary.

During the last war, Dr. Carrier said that his firm coöperated with the government in finding the answer to one of the vexing problems of shell manufacture. It was found that unless humidity conditions were rigidly controlled during manufacture, devices for timing shell explosions could not be uniformly accurate.

Airplane factories also have found air conditioning a boon in their "doping" rooms. Technically known as acetone, this dope is a health hazard for workers, in addition to being very expensive. Recovery of much of this dope from the air through a secret air conditioning process has resulted in a considerable saving in health and dollars.

Among those applications where air conditioning is proving helpful are in gun turrets of naval vessels, ammunition factories where volatile liquids are stored and in air raid shelters and gas mask manufacturing for the protection of the public.

* * *

W. A. Hanley, director of engineering, Eli Lilly and Co.; member of HPAC's board of consulting and contributing editors; nominee for president of the American Society of Mechanical Engineers — Events have shown that one nation in Europe was prepared for total war and five or six nations, although thoroughly warned, never came to a complete realization of what they must finally cope with. Old men with old ideas and old methods, resting on their laurels, let the real facts in the situation be dimmed and go without serious consideration.

During the years ahead, American industry must be prepared for whatever may come and at this time no one can make an intelligent forecast. The manufacturers in America will find difficulty in getting deliveries on important items six months from now and during the interim they should place their plants in the best state of repair so that maintenance will be at a minimum after 1940. Piping, air conditioning, plumbing, heating, lighting, elevators, conveyors and power house equipment should be modernized and made ready for the burdens which will be imposed in the vast defense program which has been launched and which will be carried out regardless of the European war and of the results of the election in November.

* * *

Samuel R. Lewis, consulting mechanical engineer and member of HPAC's board of consulting and contributing editors—It is apparent that control of relative humidity and dust will play a part of ever-increasing importance in the forthcoming rearmament program. It is known to be impracticable, for instance, to build high power airplane engines without control of the moisture and the dust in the air. We have learned the importance of such control and have developed the technique to accomplish it in making such things as watches and submarine cables.

Recent surveys of several large manufacturing plants have disclosed a tendency to limit expenditure on boilers and combustion appliances with the result that they would be incapable of assuming any substantial increase in load. Under the present situation it would apparently be wise for manufacturers immediately to rejuvenate their boiler plants and to have the power and heat ready in advance against the reasonably expected, increasing demand for materials and to adjust the shortage, now evident, of skilled building trades workmen.

* * *

Defense Housing—More than 450 local housing authorities will be enlisted in the defense housing program as a result of amendments to HR 9822 (to expedite naval shipbuilding, and for other purposes) recently passed by congress, says the bulletin "Public Housing," issued by the United States Housing Authority.

The USHA and the war and navy departments are authorized to coöperate in making housing available for persons engaged in national defense activities, including (1) enlisted men with families, (2) employees of the navy and war departments, and (3) defense industry workers and their families.

* * *

Defense Information—The bureau of foreign and domestic commerce has compiled a list of army and navy procurement offices throughout the country and points out that current information on industrial mobilization for national defense is best secured from the field purchasing offices of the navy department and the field procurement offices of the war department rather than from government agencies in Washington. Officials at the field offices are kept in close touch not only with present purchasing needs but also with all other mobilization matters pertaining to their areas, according to Bruce Berckmans, assistant director of the bureau.

According to the listing, there are army **air corps** procurement district offices in Dayton, New York and Santa Monica, Calif.

Army **chemical warfare** service procurement district offices are in Boston, Chicago, New York, Pittsburgh and San Francisco.

Army **engineer** procurement district offices are in Chicago, Mobile, New York, Philadelphia, Pittsburgh and San Francisco.

Medical department procurement district offices are in Brooklyn, Chicago, St. Louis and San Francisco.

Army **ordnance** district offices are in Birmingham, Boston, Chicago, Cincinnati, Cleveland, Detroit, Los Angeles, New York, Philadelphia, Pittsburgh, Rochester, St. Louis, San Francisco, Springfield, Mass., and Wilmington, Del. (the latter for explosives only).

Army **quartermaster** procurement planning district offices are in Atlanta, Boston, Brooklyn, Chicago, Detroit, Jeffersonville, Ind., Philadelphia, St. Louis, Fort Sam Houston, Tex., and San Francisco.

Army **signal** corps procurement district offices are in Brooklyn, Chicago and San Francisco.

There are supply officers of the **navy** department in Alameda, Calif., Anacostia, D. C., Annapolis, Boston, Charleston, Dahlgren, Va., Great Lakes, Ill., Indian Head, Md., Key West, Lakehurst, N. J., New London, Conn., New York, Newport, R. I., Norfolk, Va., Pensacola, Philadelphia, Portsmouth, N. H., Portsmouth, Va., Puget Sound, Wash., San Francisco, San Diego, Washington and Yorktown, Va.

Most materials for the **coast artillery** corps are furnished by the ordnance department, quartermaster corps, etc., but the coast artillery purchases some materials through its field offices at Fort Monroe, Va.

* * *

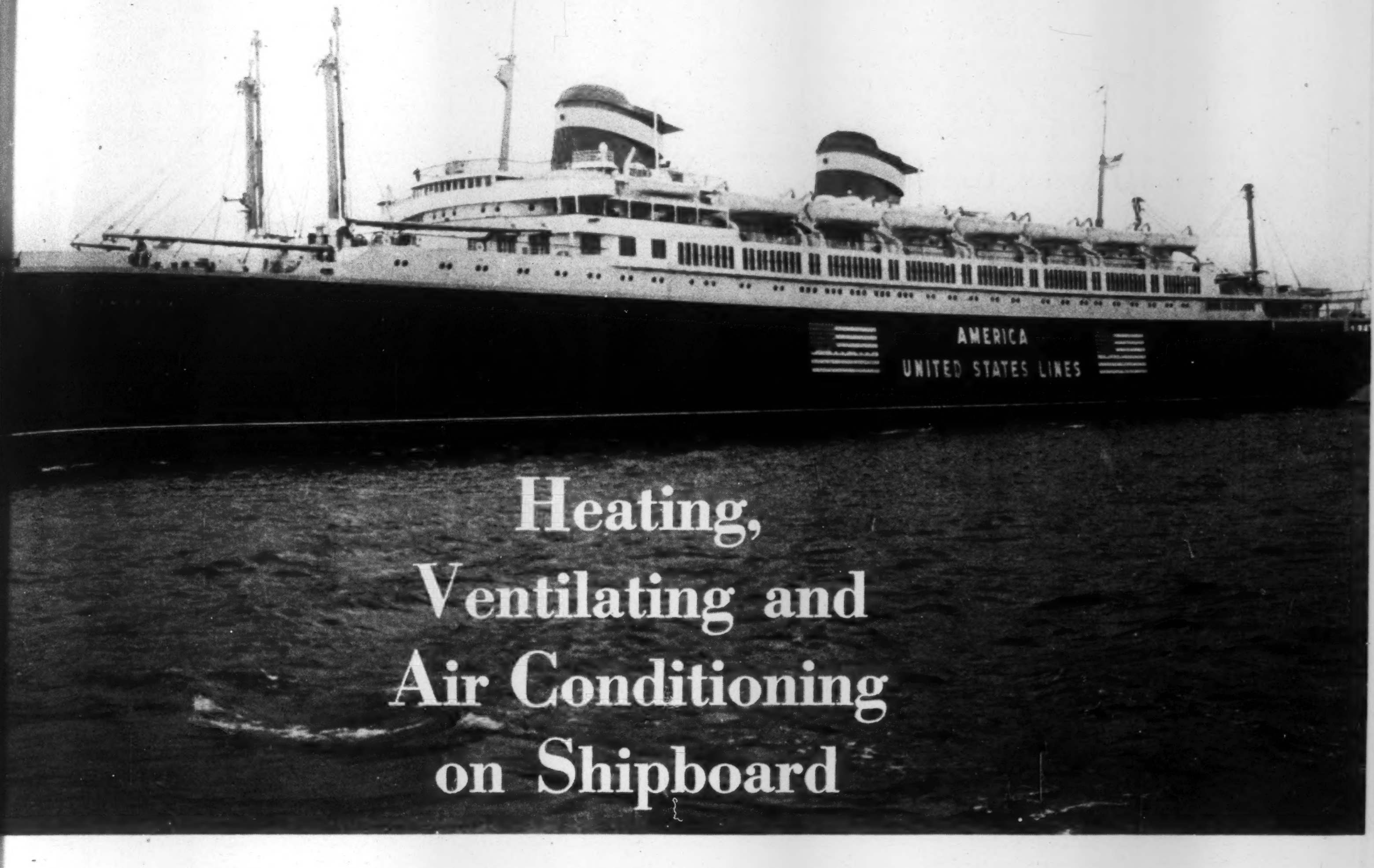
G. J. Cummings, secretary of the Scott Co., contractors, points out in a communication to the editors that there are "thousands of good mechanical contracting firms in the country ready and willing to coöperate" with the war and navy departments in construction of national defense facilities; these firms have expert men who know how to do the work, have the necessary machinery and tools, know the mechanics because they have been hiring them for years, and the mechanics know for whom they are working and therefore do more and better work.

Use of these existing organizations in connection with the defense program will promote efficiency and economy in carrying the work forward, Mr. Cummings believes, and will be much more effective than if general contractors set up their own engineering and mechanical departments or if the government organizes new facilities to do work that can easily be handled by existing firms. It is his feeling that the government should use all possible available facilities before venturing into new fields. By using the men now in the business to do the work and who are already trained for it, it will release for other work mechanics that are needed in the plane and shipbuilding industries.

An important consideration which should govern the letting of government contracts to some extent is the dislocation caused by shifting of workmen from one section of the country to another, in Mr. Cummings' opinion.

Heating·Piping
and Air Conditioning

Vol. 12, No. 8 • August, 1940



Heating, Ventilating and Air Conditioning on Shipboard

John H. Clarke* of United States Maritime Commission Explains Problems and Practices in the Marine Field

In the last 20 years there have been three outstanding periods in shipbuilding; the first was from 1917 to 1922, the second from 1927 to 1932 and the last started with the passage of the Merchant Marine Act of 1936. In between these periods there were very few merchant ships built; consequently, it is not surprising to find that with each of these periods there were startling developments in ship heating and ventilating.

During the first period, some advance was made, but all in all there was not too much thought given to ventilation and heating of ships. Cargo ships of that day

---

*Technical Div., United States Maritime Commission.

SUMMARY

There have been three outstanding periods in shipbuilding in the last 20 years, and in each of them there have been developments in ship heating and ventilating. Today, great strides in intelligent and increasing applications of air conditioning, heating and ventilating on our merchant ships are being made. Old rule-of-thumb methods are rapidly passing and naval architects and marine engineers are aware of the importance of good design, good equipment, good insulation and good adaptation of the various systems. Probably one of the most outstanding features of the present program is the emphasis placed upon proper ventilation, refrigeration and humidity control for cargo holds. . . . There are many problems of marine ventilation, heating and air conditioning peculiar to this field alone. Safety regulations are becoming more and more stringent, which means that every bit of construction in every system has become more complicated. Low headroom is a factor which presents difficulty, and is one of the reasons why any one ship ventilation system must be restricted to comparatively small capacities. Lighter materials, higher velocities and small compact units must be used wherever possible. Fans must be placed so as not to interfere with navigation, and the rolling of the ship must be considered in selecting heaters, placing fans, etc. Air filters are being installed for practically all ships; although progress is being made, flue gas from the stacks presents a problem. . . . Types of ventilation and heating systems used on ships include the split, the central, the dual duct and the unit. The main features of these types of systems are described and a later article will give further details as well as information on control. . . . All large liners today are equipped with air conditioning in the dining saloons, at least, and in some cases in the main public lounges. There is no doubt that in the future this will become more general practice

were generally heated by cast iron radiators and natural ventilation was used. Insulation was omitted in the quarters, although this was not as serious as it might sound since in some cases the construction of the deckhouses provided a certain amount of insulation. For the passenger ships—and particularly the large liners—the passengers' comfort was given more consideration. Tempered ventilation air was generally furnished, supplemented by cast iron radiators. In some cases, of which the *Southern Cross* is one, ventilation heating systems were installed. But even though fair ventilation was supplied to the better accommodation spaces, there was still a preponderance of natural ventilation, and multitudes of ventilation cowls used to be scattered all over. The equipment was somewhat crude in design, the usual type of air heater consisting of several banks manually controlled. Insulation for the first class accommodations was good because of the nature of the cabin construction, but other living spaces (particularly crew's spaces) had little or no insulation.

THE MARITIME COMMISSION PROGRAM

The Maritime Commission Program was initiated in 1936 when Congress passed the Merchant Marine Act. The purpose of the Maritime Commission is to provide about 500 new ships over a period of 10 years to replace our ever-growing number of over-age ships, and at the same time to bring about a practical coördination of replacement and retirement which will to a great extent eliminate the surges of shipbuilding for which the industry has long been noted. It is the duty of the Commission to coördinate not only the factors involved in the building program, but also those problems of design, performance, personnel, operation and finance. At the present time 159 ships have been contracted for, 41 of which have been completed. In addition one ship has been converted for use as a training ship for maritime personnel and another ship is being converted for this purpose. An outline of the progress of the program is as follows:

Type of Vessel	*Contracted for*	*Completed*
Passenger Liner	**1**	**1**
Cargo	**114**	**28**
Cargo and Passenger	**21**	**2**
Tankers	**23**	**10**
Training Ships	**2 (conversion)**	**1**

The second period of construction brought about many improvements in design and equipment and the insulation of living spaces was given more attention. In the early '30's the "dual duct" system of ventilation heating was developed and for the first time in our merchant marine, air conditioning was installed. It was limited to the dining saloons but at least it was a beginning.

Today we are making even greater strides by intelligent and ever increasing applications of air conditioning, heating and ventilation on our merchant ships. The old rule-of-thumb methods are rapidly passing out and naval architects and marine engineers are aware at least of the importance of good design, good equipment, good insulation and good adaptation of the various systems now at our disposal.

Probably one of the most outstanding features of the present program is the emphasis placed upon proper ventilation, refrigeration and humidity control for cargo holds. No ship on the present program will be built without some of the holds being mechanically ventilated. When these ships are completed, there will be a hig percentage of refrigerated capacity available for froze products, fruits and vegetables. The latter spaces, o course, require large volumes of recirculated air. A least 26 of the 135 cargo ships which have been built o contracted for at this time will be equipped to contr completely the humidity in the general cargo holds an thus protect these cargoes from damage due to moistu or sweating. Undoubtedly there will be many more suc installations in the future.

Many Problems in Marine Work

There are many problems of marine ventilation, heating and air conditioning peculiar to this field alone. Safety regulations are becoming more and more stringent with the result that almost every bit of construction and every system installed has become more complicated. For instance, the *America* has 14 watertight bulkheads and five main fireproof divisions. Under present specifications no ventilation trunk can pierce any of the main bulkheads; this means that each section must have its own supply and exhaust system, excepting above the bulkhead deck. It means also that no piping may pierce any of the above bulkheads or decks without being fitted with watertight connections. For ships like the *America*, horizontal fire zones are also laid out, and vertical ducts going through these decks must be protected with fireproof dampers. To prevent the spread of fire on shipboard the present safety rules require that all fan systems except those for the engine spaces must have a central control by which they may be shut down. Where it may be necessary for ducts to pierce watertight bulkheads, as it sometimes is on merchant ships, then a watertight valve must be fitted and the duct must be strengthened to withstand the hydrostatic head.

Another factor or difficulty which must be overcome for shipboard ventilation is the low headroom. Deck heights vary from a minimum of 8 ft, 6 in. to 9 ft, 6 in. for passenger and cargo ships. Under these decks and on the bulkheads are various beams, girders and stiffeners which may be up to 9 in. in depth and which reduce the headroom still further. This means that all ducts in such spaces must be constructed with a maximum depth in most cases of 6 in., the width being restricted either by the spacing of beams or other structure, or by good design. These are several of the main reasons why the size of any one ship ventilation system must be restricted to comparatively small capacities.

With some exceptions, it is generally impractical to recirculate air in living spaces on shipboard, and few such installations have been made. Individual systems for supply, exhaust or both must be provided for the living spaces (staterooms, public spaces); hospital spaces; galleys, pantries and sculleries; toilet, shower and washrooms; air conditioned spaces; engine, boiler and machinery spaces; and all cargo holds. It is obvious that no recirculation could be attempted except to a limited extent without the possibility of contaminating the air or getting odors.

No ventilation intakes can be situated in the shell plating due to strength and weather limitations, so that fan intakes are limited for the most part to the uppermost deck of the ship. For this reason the fans and fan rooms are also placed on the upper decks, in order to minimize suction pressures which might reduce fan efficiency. This location of fans is not entirely a disadvantage but sometimes it does mean that the ducts must be unusually long, which means higher static pressures for the systems.

Weight and cost are both important on shipboard so that the best compromise must be made. This means that lighter materials, higher velocities and small compact units must be used wherever possible. For the same reason, and also because the higher pressures are available, the steam supplied to heating units is at a much higher pressure than for ordinary commercial practice; this permits the use of equipment 25 to 50 per cent smaller in nominal size and weight. The same reasoning accounts for the use of high capacity axial flow fans wherever possible. Since the ship structure is of steel (as are most of the materials in the ship) extreme care must be exercised to eliminate possible causes of vibration and noise. In the placing of fans it is important to be sure that any noise which they may make will not interfere with navigation. In some cases fans have been situated on the upper decks or in kingposts[1] near the bridge and have been so noisy that they had to be shut down while the ship was navigating through fog so that the navigating officers could hear danger signals. This sort of difficulty must be avoided on any ship.

The rolling of a ship must be considered in selecting air heaters, etc., so that proper drainage is afforded. Along this same line and where practicable, the axes of all fans of appreciable size should be placed in a fore-and-aft position to prevent bearing wear, particularly where sleeve bearings are used. The reason for this is that a ship rolls two or three times as much as it pitches, and consequently, the gyroscopic action of a fan when the ship is rolling can have a serious effect on the bearings. This is true of course of all equipment on shipboard which rotates at high speed and has a high inertia factor.

As with land plants, ships have to provide for the elimination of solids in the ventilation systems. Air filters are now being installed for practically all ships. Coupled with the use of centrifugal soot removers in the smoke pipes, much has been done to eliminate this source of trouble. But there is still another source of annoyance on shipboard and that is flue gas from the stacks. It can be appreciated that it is not always possible to place ventilation intakes ahead of the stacks, and even where they are placed forward of the stacks there are apparently cases where eddy currents have carried flue gases down the outside of the stack casing and forward to fan intakes even when going into the wind. This raises a serious problem to which the Commission is trying to find a solution. Perhaps the solution is in higher stacks, sheltered intakes from decks under the uppermost deck, or perhaps in the future some enterprising naval architect or marine engineer may devise a practical method of ejecting the boiler gases at the stern of the ship.

Types of Ventilation Used

There is a large variety of ventilation systems used on ships depending on the service to be performed; in general they can be subdivided into the quarters, machinery spaces and cargo ventilation systems. The types of systems for accommodations and quarters include the split, central, dual duct, and unit.

Split System—The split system consists of heating with radiators and supplying either unheated (which is rare) or heated ventilation air at about 70 or 80 F. This system is chiefly confined to cargo ships or to crews', third class, and certain office and working spaces on passenger ships. As a notable exception, electric convection radiators using black heat and a stack within a stack in order to get good air movement without high enclosure temperatures have been installed in cabin class staterooms of the *Queen Mary, Mauretania* and *Queen Elizabeth*. This split system is a rather good and foolproof system for both ventilation and heating, and where steam is the heating medium it is economical in installation and weight. It has the advantage of reducing the air volume that must be handled, and a material saving in heat is effected, since the radiators heat recirculated air only.

Central System—Today the central system is taking the place of the split system for cargo ships. In some cases it has been used for passenger ships and there is no reason why it should not find a wider field of application, if it is properly designed and installed. The advantage of this system is that it requires little equipment and space beyond that already required for ventilation. Air is taken into a fan room situated usually (in cargo boats) on the boat deck just forward of the stack. The air is in most cases filtered and then run through a preheater and reheater and brought to the final temperature necessary to heat the compartments to the specified temperature, about 70 F. The necessary maximum final air temperature may be anywhere from 90 to 110 F, depending upon the volume of air supplied and the outside air temperature upon which the heat loss is based. Controls are provided so as to regulate the heating.

While compact and economical, this system does have the disadvantage that it cannot be regulated to suit individual requisites for heat and cold except by damper control. For this reason the central system must have good temperature control and must be well engineered and balanced to begin with. A good compromise must be made and the system must be carefully balanced so as to avoid overheating some compartments and underheating others. This balance is achieved by supplying the air in direct proportion (within 25 cfm increments) to the winter heating requirements. The volume handled by the whole system is then increased so that there will be sufficient air supplied in all spaces for summer ventilation. This will provide an air change of from about four to eight minutes or an average of six minutes and will mean of course that

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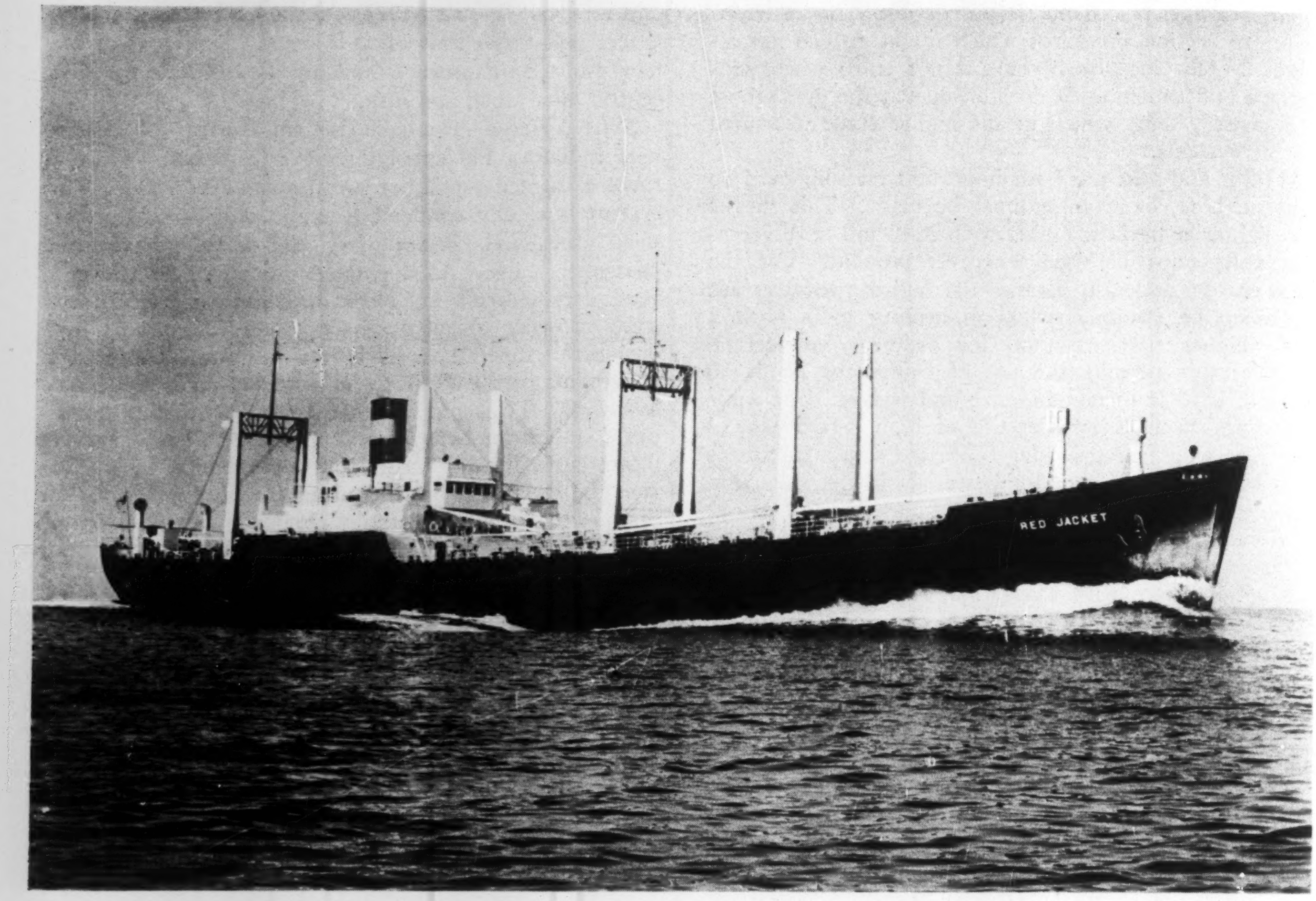
[1] Hollow posts usually situated port and starboard at convenient points to carry the cargo boom steps and topping rigging.



S.S. *Red Jacket*, a C-2 cargo ship. Ventilation grilles may be seen on the first and fourth of the five sets of kingposts (hollow posts usually situated port and starboard at convenient points to carry the cargo boom steps and topping rigging.) The kingposts are used wherever possible for cargo hold ventilation. They may be used either for supply or exhaust. In some cases the kingposts are divided and used for supply for the hold forward and exhaust for the hold aft of the kingpost. Ordinary ventilation cowls are shown, one at the bow and two at the stern. Two special exhaust heads are situated in the two columns on the forecastle deck above the ship's name. Mushroom vents may be noted at various points. Ail intakes are baffled or otherwise protected so as to exclude spray during rough weather

some spaces may have excess air in the summer, but this is not serious and it is essential that the compartments be evenly heated. Such variations as exist after this system has been balanced can be adjusted by means of the damper at each outlet. The temperature controls for this system will be discussed later.

Dual Duct System—The dual duct system is installed for passenger ships only, has been in use for about 10 years and has been installed in many of the large liners. The *Queen Mary, Mauretania* (new), *America*, the three new Panama ships and the majority of the Maritime Commission's passenger ships have this system installed either for the passenger accommodations or for the entire quarters ventilation heating system. It consists of two ducts, one for hot air and one for cool air, both terminating at a common outlet. The two ducts may be run parallel, being separated by insulation so as to prevent heat transfer, or the lines may be run independently, the only provision being that each outlet is properly supplied. Each outlet is supplied either with a single mixing damper or else a damper for each duct, as is the case on the *America*, so that the stateroom occupants can select the desired temperature of the mixed air. The last method is preferred since with a damper for each duct it is possible to control the volume as well as the temperature at the outlet. The air in the cool ducts is tempered to 50 or 60 F. The 60 F temperature is advantageous since smaller reheaters may be used and since the equivalent of low limit control is provided. The air in the hot ducts is either maintained at 130 F or is varied so that with an outside air temperature of 75 F the hot air temperature is 75 F and with an outside air temperature of 30 F the hot air temperature is at the maximum (about 130 F).

This latter system has the advantage of requiring a minimum of damper adjustment, excepting below 30 F when it would be necessary to adjust the heating by shutting off the cold air. When a constant hot air temperature is used, wide and varying damper adjustments must be made to obtain the proper temperatures and to adjust these temperatures to compensate for outside temperature changes. The changes in climate conditions which are frequent in the marine field, coupled with the fact that the dampers are not air tight, have caused difficulty through overheating. The dual duct system is more expensive than the two systems previously described but it has been one answer to the ever increasing demand for good ventilation and heating in passenger quarters.

Unit System—This system may consist of either heating, or combined heating and air conditioning (or air cooling) units supplied with tempered air in the winter. Where heating only is supplied the air is tempered to 50 or 60 F and either terminal heaters are provided in each compartment with room thermostats to control the modulating valves or else a single reheater is used to serve two, three or four compartments or staterooms. This system is best adapted for heating the lounges and other public spaces.

Where air conditioning (or air cooling) units are supplied they may be of the semi-self-contained, or the self-contained type. The stateroom units are semi-self-contained air coolers and are similar in appearance to ordinary radiators. Each unit has a recirculating fan, circulating water coil, air filter and drain for condensed moisture. About 75 per cent of the air through the units is recirculated, the rest being supplied by a duct connection to the ventilation system. Heating or cooling is controlled mainly by a modulating valve and thermostat which control the water circulating rate, but additional manual control of the fan speed is also provided. All units are fitted with a damper adjustment so that the volume of recirculated air may be regulated. For winter operation the ventilation air is preheated to 40 F and the circulating water temperature is maintained at 150 F by a heat exchanger in the refrigerating machinery room. For summer operation, chilled water at about 45 F is supplied. None of these units has as yet been installed although they will be installed in several of the passenger ships now building, and they will also be used in the cabin and tourist staterooms on the two large liners the Commission expects to build soon.

As a variation of the above system, another group of passenger ships is being built with larger units supplying four or five staterooms through supply and recirculating ducts. These units are similar to the stateroom units as far as purpose and equipment are concerned and are to be placed in small fan rooms allocated solely for this purpose and in close proximity to the staterooms served. Cooling is controlled to average conditions and the individual desires are obtained through damper control. The advantage of this system is that it saves the space which a stateroom unit would otherwise require.

Air Conditioning of Public Spaces

All large liners today are equipped with air conditioning in the dining saloons at least and in some cases in the main public lounges. There is no doubt that in the future this will become general practice for all passenger ships, and particularly for those on routes through tropical climates. The units for this purpose are also semi-self-contained and have in the past been provided with brine sprays or brine circulation for cooling. The latter is used for the units of the *America*, but direct expansion of "Freon-12" or circulating cold water will probably be used on future installations.

With such units as those for the dining saloons on the *America* all heating or cooling is done in the unit. Preheating in the winter is done by mixing return air with the outside air. All air through the unit is filtered before going to the compartment served. Outside air, recirculating and bypass ducts are run to the unit, which consists of filters, brine coils, steam coils and blowers. The refrigerating equipment and brine coolers are placed on the deck below, directly under the unit. Heating, and summer cooling and humidity regulation, is by means of motorized dampers controlled by thermostats and humidistats. Function of the dampers is to control the volumes of bypassed air in relation to the mixture of the recirculated and outside air so as to maintain the desired air outlet or room conditions. Humidification is not provided for winter operation.

Still another type of unit, the self-contained air cooler, is used on the *America* and other liners. These units are complete with compressor, condenser, direct expansion coils, filters, fan and drains. They are placed between adjoining beauty and barber shops and their sole purpose is to cool recirculated air in these spaces. Ventilation air is supplied to the spaces either directly or, preferably, through the units. These units can be supplied with heating coils if desired, but so far no such installation has been contemplated.

Excepting the units last described, the above systems are used for ventilation and heating or cooling. In addition, ventilation air must be provided for galley, pantry, scullery, laundry and other similar places. Sometimes this air is tempered to 50, 60 or 70 F but more often it is supplied directly from the outside.

Supplementing the various ventilation systems are steam and electric radiators, unit heaters and electric heaters. Radiators are usually supplied in all toilet, washroom and shower spaces with outside exposure, as well as in the wheelhouse, carpenter shop, steering gear room and sometimes in the windlass room. Unit heaters have occasionally been furnished for some of the above mentioned working spaces and in the engine rooms of some diesel ships.

Electric heaters have been furnished in winch resistor rooms in order to keep the electrical equipment and resistors dry. No attempt is made actually to heat these spaces electrically since the electrical load would be prohibitive and the equipment is not well adapted for it. Electric heaters are now being specified in radio and master gyro-compass rooms in lieu of steam radiators so as to avoid possible damage to equipment by leaking steam.

[*A second article will cover control, details of design and installation and machinery space and cargo ventilation.*]

Air Conditioning an Essential in Many Industrial Processes

● Color work on lithograph metal sheets has been materially improved through elimination of "tackiness," sticking and offsetting as a direct result of air conditioning the lithographing department of Federal Tin Co., Baltimore, Md. Better working conditions also have resulted from the air conditioning installation through a reduction in room temperatures and increased air cleanliness. The better air conditions within the litho department also result in a reduction in soot and carbon on the litho oven burners. Formerly it was necessary to clean these burners at the rate of 12 or 15 per week, whereas the average now is about one burner every five or six weeks. Improvement in the condition of the product can be traced to the fact that the sheets now come off perfectly cool and dry, and are easier to handle, being immediately ready for the next stage, with a great reduction in spoilage, and also speeding production.

AWS Committee Compiles

Definitions of Welding Terms

These definitions of welding terms have been taken from a standard prepared by the committee on definitions and chart of the American Welding Society and approved recently by the executive committee of the Society as "tentative." They were published in full in The Welding Journal of the AWS (April, 1940) and the excerpts given here are reproduced by permission of the Society

Arc Welding: A non-pressure (fusion) welding process wherein the welding heat is obtained from an arc either between the base metal and an electrode, or between two electrodes.

Backhand Welding: A gas welding technique wherein the flame is directed opposite to the progress of welding.

Back-Step Welding: A welding technique wherein the increments of weld metal are deposited opposite to the direction of progression.

Backing Strip: Material (metal, asbestos, carbon, etc.) backing up the root of the weld.

Bare (Lightly Coated) Electrode: A solid metal electrode with no coating other than that incidental to the manufacture of the electrode, or with a light coating.

Base Metal (Parent Metal): The metal to be welded or cut.

Bond: The junction of the weld metal and the base metal.

Composite Joint: A joint wherein welding is used in conjunction with a mechanical joint.

Concurrent Heating: Supplementary heat applied to a structure during the course of welding.

Continuous Weld: A weld which extends continuously for its entire length.

Covered (Shielded Arc) Electrode: A metal electrode which has a relatively thick covering material serving the dual purpose of stabilizing the arc and improving the properties of the weld metal.

Deposited Metal: Metal that has been added by a welding process.

Deposition Efficiency: The ratio of the weight of deposited metal to the net weight of the electrodes consumed (exclusive of stubs).

Electrode:

A. *Metal Arc Welding:* Filler metal in the form of a wire or rod, either bare or covered, through which current is conducted between the electrode holder and the arc.

B. *Carbon Arc:* A carbon or graphite rod through which current is conducted between the electrode holder and the arc.

C. *Atomic Hydrogen:* One of two tungsten rods between the points of which the arc is maintained.

D. *Resistance Welding:* A bar, wheel or die through which the current is conducted and the pressure applied to the work.

Filler Metal: Material to be added in making a weld.

Forehand Welding: A gas welding technique wherein the flame is directed toward the progress of welding.

Free Bend Test Specimen: A specimen which is tested by bending without constraint of a jig.

Full Fillet Weld: A fillet weld whose size is equal to the thickness of the thinner member joined.

Fusion Welding: A group of processes in which metals are welded together by bringing them to the molten state at the surfaces to be joined, with or without the addition of filler metal, without the application of mechanical pressure or blows.

Gas Welding: A non-pressure (fusion) welding process wherein the welding heat is obtained from a gas flame.

Guided Bend Test: A bending test wherein the specimen is bent to a definite shape by means of a jig.

Neutral Flame: A gas welding flame wherein the portion used is neither oxidizing nor reducing.

Oxidizing Flame: A gas welding flame wherein the portion used has an oxidizing effect.

Pass: The weld metal deposited by one general progression along the axis of a weld.

Peening: Mechanical working of metal by means of hammer blows.

Penetration: The penetration, or depth of fusion, of a weld is the distance from the original surface of the base metal to that point at which fusion ceases.

Piping—Positions for Welding:

(a) *Horizontal Fixed Position:* When the axis of the piping is in a horizontal position and the piping is not rotated during welding. In this position welding is done in the flat, vertical and overhead positions.

(b) *Horizontal Rolled Position:* When the axis of the piping is in a horizontal position and the piping is rotated during welding. In this position welding is done in the flat position.

(c) *Vertical Position:* When the axis of the piping is in a vertical position the piping may or may not be rotated during welding. In this position welding is done in the horizontal position.

Porosity: The presence of gas pockets or inclusions.

Postheating: Heat applied subsequent to welding or cutting operations.

Preheating: Heat applied prior to welding or cutting operations.

Rate of Deposition: The weight of weld metal deposited in a unit of time.

Reducing Flame: A gas welding flame wherein the portion used has a reducing effect.

Residual Stress: Stresses remaining in a structure or member as a result of thermal or mechanical treatment, or both.

Slag Inclusion: Non-metallic material entrapped in a weld.

Spatter Loss: The difference in weight between the weight of electrode deposited and the weight of the electrode consumed (melted).

Stress Relief Heat Treatment:* Uniform heating of a structure or portion thereof to a sufficient temperature below the critical range, to relieve the major portion of the residual stresses, followed by uniform cooling.

Weaving: A technique of depositing weld metal in which the electrode is oscillated.

Welding Procedure: The detailed methods and practices involved in the production of a welded structure.

Welding Rod: Filler metal, in wire or rod form, used in the gas welding process and those arc welding processes wherein the electrode does not furnish the metal.

Welding Tip: A gas torch tip especially adapted for welding.

*Note: Terms normalizing, annealing, etc., are misnomers for this application.

Heating by Reversed Refrigeration

A. J. Lawless* Explains Principle of Using the Reversed Refrigeration Cycle for Heating, Describes Such a Job

SUMMARY

In order that the all-electric heating and air conditioning installation in the new building of the United Illuminating Co. might be comparable in operating cost with either coal or oil for fuel, the reversed refrigeration cycle for extracting heat from 55 F well water is employed. In the reversed cycle, the cooled medium is discarded from the system and the heat removed from the medium becomes the useful work of the system. In the simple air conditioning refrigeration cycle, for every 200 Btu removed from the cooled medium, approximately 47 Btu of equivalent electrical energy is consumed; allowing for outside losses, approximately 240 Btu must be removed from the condensers. This indicates that for every Btu of electrical energy used, 5.1 Btu is given up by the condensers. In reversed cycle heating systems this ratio of performance is decreased somewhat because of the increase in compression ratio in order to obtain condensing temperatures sufficiently high for heating purposes. The overall ratio of the system is also further decreased slightly, depending upon the additional electrical energy for the pumps and other equipment performing at a 1 to 1 ratio. . . . Factors influencing the practicality of the reversed refrigeration cycle for building heating include the availability of a source of outside heat, cost of electrical energy, and whether or not summer air conditioning is desired. In some industries where refrigeration is required for processing in winter, it would be possible to use the heat given up by the condensers for heating purposes. . . . There are two natural sources from which heat may be extracted in winter: outside air and water. In cold climates, water becomes the only practical source and in the case under consideration private wells are used. In the winter the well water is cooled by the refrigeration evaporators and discarded; the heat removed is given up by the condensers to a closed system of hot water heating. In summer the well water is pumped through the evaporators, delivered to the various cooling units in the building, and then returned to the condensers and discarded. . . . A second article will describe details of this heating and air conditioning system, its control and its operation

THE UNITED ILLUMINATING CO., the electric utility serving New Haven, Conn., Bridgeport and surrounding communities, has just completed a new administration and service building heated and air conditioned entirely by electrical energy. In order that such an installation might be comparable in operating cost with either coal or oil as fuel, it was decided to use a system employing the "reversed refrigeration cycle" method of extraction of heat from a natural outside source. The system as installed is one of the largest and most complete reversed cycle installations ever attempted.

The new administration and service building of the United Illuminating Co. is heated and air conditioned entirely by electrical energy. The reversed refrigeration cycle is used for heating, the source of heat being 55 F water from six wells

The building is three stories high, with towers and basement, and is divided into two general areas. The service area, comprising most of the basement and two-thirds of the first floor and totaling approximately 60,000 sq ft, is used for garage and equipment service from which the entire distribution system of the company is maintained. The remainder of the first floor and the second and third floors, totaling 55,000 sq ft, contain the business and administration offices of the company.

The system as installed provides for heating and ventilation of the service areas, and for complete summer and winter air conditioning of the office areas.

Principle of the Reversed Cycle

In the common refrigeration cycle heat is extracted from a heat containing medium in the evaporator of the refrigeration system, and given up from the system through the condensers. The useful work accomplished by the system is the cooling of the medium, and the heat removed from the medium is discarded by the system. In reversing the refrigeration cycle the cooled medium is discarded from the system, and the heat removed from the medium becomes the useful work of the system. As the actual temperature of the medium from which the heat is removed is too low for heating purposes, this heat is "lifted" by the refrigeration system and given up by the condensers to the condensing medium at a temperature sufficiently high for proper heating.

In the simple refrigeration cycle as used in air conditioning, the compressor motor size is approximately 1 hp per ton of refrigeration developed. Thermodynamically, allowing for motor losses, for every 200 Btu per min removed from the cooled medium, approximately 47 Btu equivalent electrical energy is consumed by the system, and therefore, again allowing for motor and outside losses, approximately 240 Btu per min must be removed from the system by the condensers. This indicates that for every Btu of electrical energy used, 5.1 Btu is given up by the condensers.

In reversed cycle heating systems this ratio of performance is decreased, because of the increase in the compression ratio in order to obtain condensing temperatures sufficiently high for heating purposes. With varying condensing temperatures as suitable for heating, it is possible to obtain an average ratio of performance of approximately 1 to 4, based on a full year's operation. The overall ratio of the system is again slightly decreased, depending on the additional electrical energy for the pumps, etc. (performing at approximately a 1 to 1 ratio), that may be required to complete the system.

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*Partner in the firm of Hubbard, Rickerd and Blakeley, Consulting Engineers.

With a source of outside heat available from which the 200 Btu per min per ton may be conveniently extracted, the advantage of the reversed cycle over direct electrical heating, which has only a 1 to 1 performance ratio, can readily be seen.

Two Natural Sources of Heat

There are two natural sources from which heat may be extracted in the winter: outside air and water.

In the warmer climates, where the outside temperature rarely goes below 40 F, outside air may be used as the medium from which heat may be extracted. In cold climates, the problem of moisture freezing is difficult to overcome and the low evaporating temperature at which the refrigeration system must operate materially decreases the ratio of performance to a point where increased cost of the installation of the "reversed cycle" system is not warranted.

In cold climates water therefore becomes the sole natural source of outside heat. In some localities the municipal water supply might be used if it is not expensive or too low in temperature. In other localities individual private wells might be most advantageous. In either instance, water temperatures below 50 F might, as with cold air, also indicate that the installation of the reversed cycle system is not warranted.

Cost of Electricity

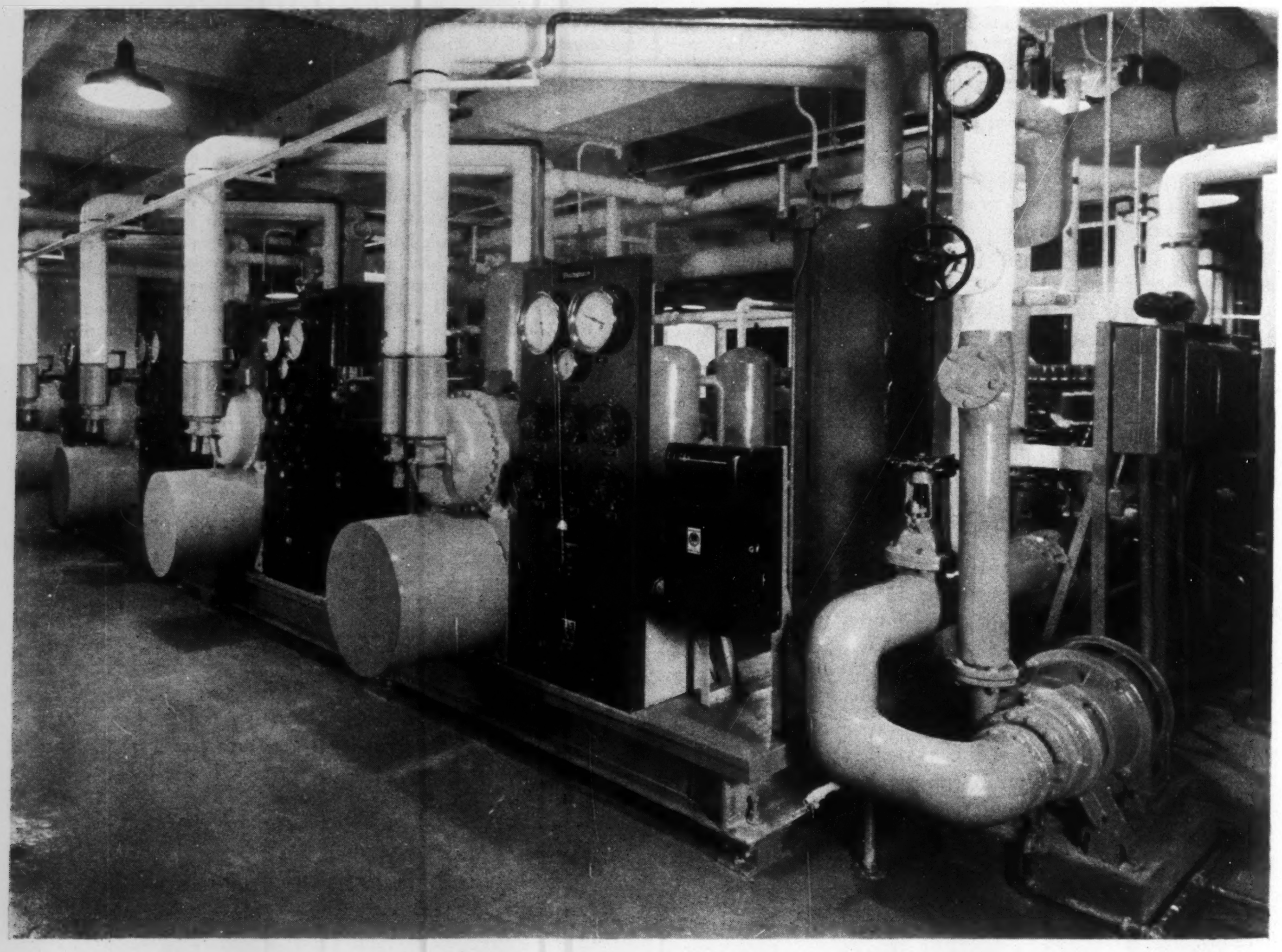
Irrespective of the availability of outside heat the economic value of the reversed cycle system of heating is dependent on the cost of electrical energy.

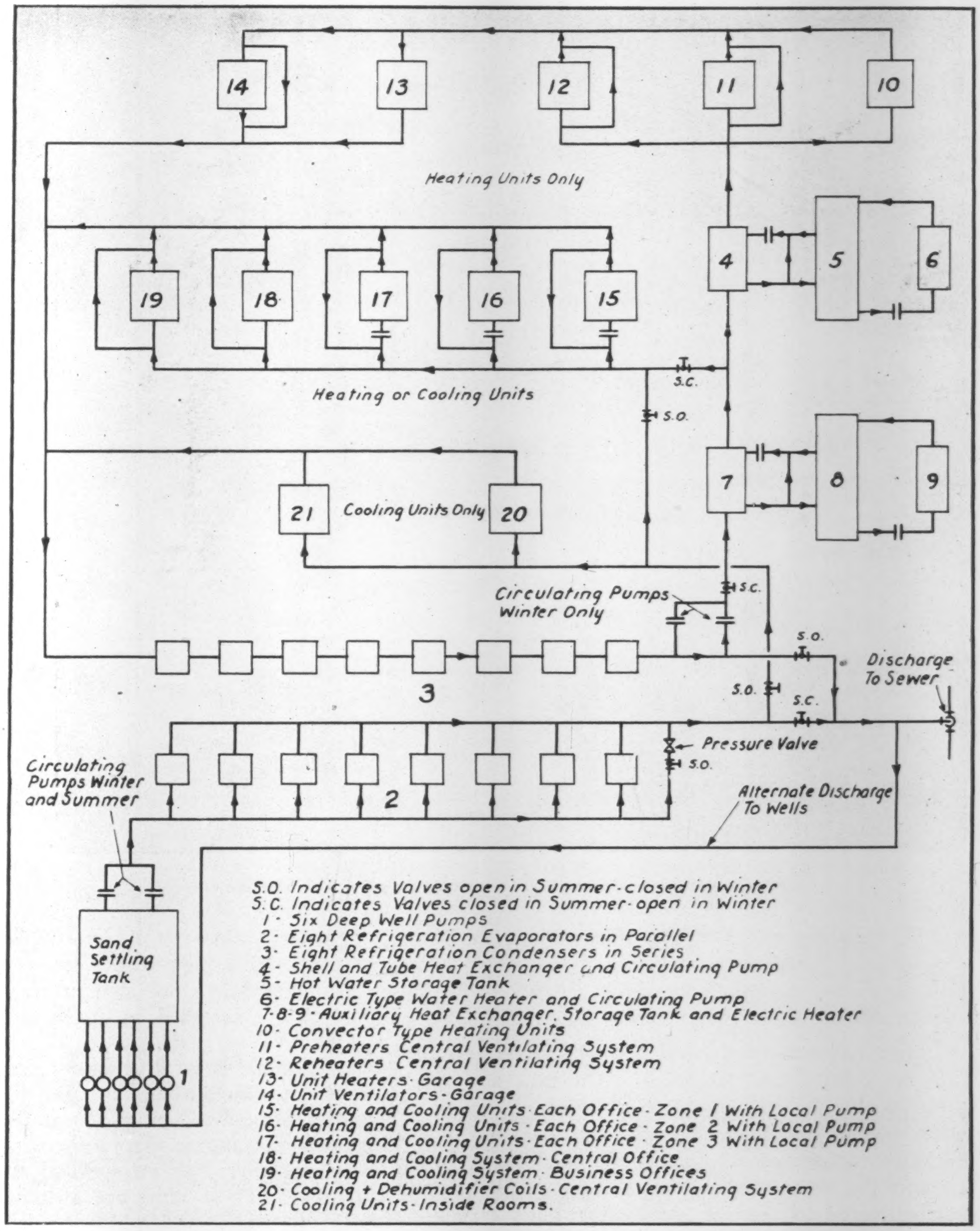
The cost of electrical energy to the average consumer in most localities is such that the installation of the reversed cycle system for heating only is not warranted. But in installations where both winter heating and summer air conditioning is desired, particularly in the warmer climates where the reversed cycle heating load balances the air conditioning refrigeration load and therefore where additional installed refrigeration is not required for heating, there might be an economic value to a reversed cycle system over a conventional heating system plus an independent air conditioning system.

Again, in some industries where refrigeration is required for processing during the winter, it would be possible to use the heat given up by the condensers for heating purposes.

In the United Illuminating Co. installation—because of the availability of an outside source of heat, the low cost of electrical energy, and the desire for summer air

The compressor units and condenser heating pumps




14
13
12
11
10
Heating Units Only
4
5
6
19
18
17
16
15
S.C.
Heating or Cooling Units
S.O.
7
8
9
21
Cooling Units Only
20
S.C.
Circulating Pumps Winter Only
S.O.
Discharge To Sewer
S.O.
3
S.C.
Pressure Valve
S.O.
Circulating Pumps Winter and Summer
2
Alternate Discharge To Wells
Sand Settling Tank
1
S.O. Indicates Valves open in Summer-closed in Winter
S.C. Indicates Valves closed in Summer-open in Winter
1 - Six Deep Well Pumps
2 - Eight Refrigeration Evaporators in Parallel
3 - Eight Refrigeration Condensers in Series
4 - Shell and Tube Heat Exchanger and Circulating Pump
5 - Hot Water Storage Tank
6 - Electric Type Water Heater and Circulating Pump
7-8-9 - Auxiliary Heat Exchanger, Storage Tank and Electric Heater
10 - Convector Type Heating Units
11 - Preheaters Central Ventilating System
12 - Reheaters Central Ventilating System
13 - Unit Heaters - Garage
14 - Unit Ventilators - Garage
15 - Heating and Cooling Units - Each Office - Zone 1 With Local Pump
16 - Heating and Cooling Units - Each Office - Zone 2 With Local Pump
17 - Heating and Cooling Units - Each Office - Zone 3 With Local Pump
18 - Heating and Cooling System - Central Office
19 - Heating and Cooling System - Business Offices
20 - Cooling + Dehumidifier Coils - Central Ventilating System
21 - Cooling Units - Inside Rooms.

Simplified diagram of the entire heating and cooling system. In winter the well water—the source of heat—is cooled by the refrigeration evaporators and the water discarded. The heat removed is given up by the condensers to a closed system of hot water heating. In the summer the well water is pumped through the evaporators, delivered to the various cooling units in the building, then returned to the condensers and discarded

conditioning — it was determined that even with the unbalance in the heating and cooling loads, the reversed cycle system had sufficient advantages over a conventional heating system plus a separate air conditioning system to warrant its installation.

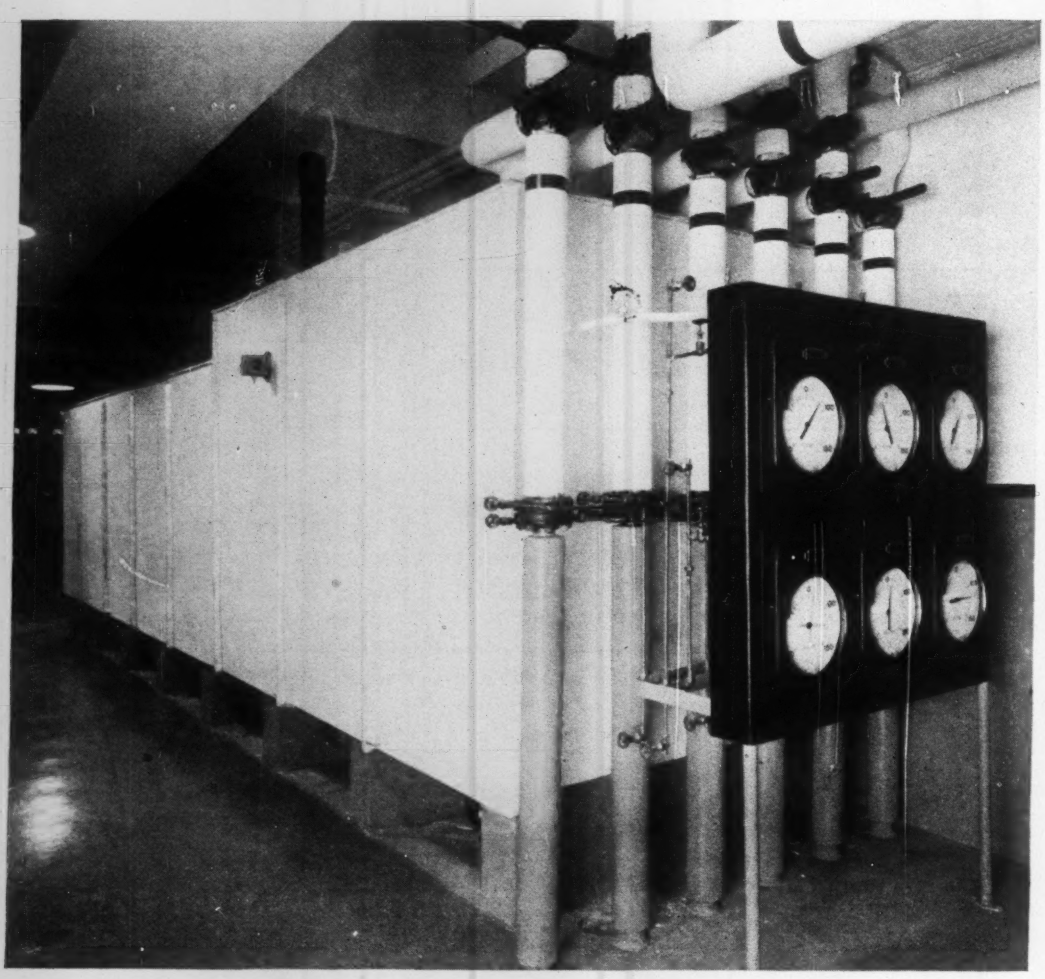
Because of the "unbalanced" load it was found more economical to design the reversed cycle system for 20 F above the usual design base temperature, augmenting it with direct electrical conversion heating.

This unbalanced load is caused principally by the large garage area requiring ventilation. The garage in this installation, unlike a public garage, requires ventilation only for short periods throughout the day. Being a private service garage, very little traffic occurs except as the service cars leave in the morning and return at night. Although on an hourly rate basis the garage ventilation load is approximately 30 per cent of the total heating load of the entire installation, the actual 24 hr demand is a very small percentage of the total demand. This also was a deciding factor in the determination of the capacities of reversed cycle and direct electrical heating systems.

Private Wells Furnish Heat

Private wells were found most advantageous as a source of outside heat. The building lies directly over a large body of underground water having unlimited capacity and the water from this underground stream is at a constant temperature of 55 F throughout the year. The large area of the building plot (approximately 200 ft square) was also adaptable to the sinking of wells, having sufficient spacing so as not to affect materially the level of the underground water.

Six deep wells were driven in the basement to an average depth of 28 ft below the basement floor. Each well consists of a 10 in. diameter well pipe within a 36 in. diameter steel casing filled with gravel. The wells have a static level of 3 ft and a pumping level of 20 ft below the basement floor, and their total capacity is 600 gpm.



The sand settling tank, showing well pump supplies and flow meters

A central system of ventilation was installed for air conditioning. This system handles outside air only, cooling and dehumidifying it in the summer, heating it to room temperature and humidifying it in the winter, and delivering it through ducts to all air conditioned rooms. In the small offices this air is delivered through grilles in the corridor walls.

In each small office a local cooling and heating unit is installed under the windows. It consists principally of a fin type coil and motor driven fan assembly, and recirculates room air only. The coil, furnished with hot water in the winter and cold water in the summer, provides for local heating or cooling as required. Similar units are installed in interior rooms and furnished with cold water in summer only.

Heating and Cooling Flow Diagram

A simplified reproduction of the entire heating and cooling system is given in the flow diagram.

In the winter the well water is cooled by the refrigeration evaporators and discarded. The heat removed is given up by the condensers to a closed system of hot water heating and pumped to the various types of heat exchange apparatus throughout the building. In the summer the well water is pumped through the evaporators, delivered to the various cooling units throughout the air conditioned area, and then returned to the condensers and discarded.

In some offices, particularly those on the north side of the building and which have high winter heat losses and relatively low summer heat gains, convectors operating in the winter only are installed in addition to the above-mentioned units.

For the large first floor offices and commercial areas where it would be impractical to use window units, central fan and coil units are installed. These units receive their outside air from the central system and distribute it, together with recirculated air, through ducts to the areas. These units are also furnished with hot water in the winter and cold water in the summer.

[*A second article will describe details of the installation, its control and operation.*]

EEI Survey Shows Spread of Air Conditioning

The 1940 survey of air conditioning installations in the United States, broken down into business classifications and just released by C. E. Greenwood, commercial director of the Edison Electric Institute, 420 Lexington Ave., New York, N. Y., is a comprehensive study of air conditioning progress. The 183 utility companies represented in the report serve 75,000,000 people, or more than half of the country's total population. The number of installations reported is 42,604, which use a total of 873,024 hp.

One-fourth of all these air conditioning installations are in offices and office buildings; one-fifth are in restaurants and retail stores, and one-fifth are in apartments. The remainder are scattered among nearly two dozen different commercial and industrial classifications, including banks and barber shops, beauty parlors and broadcasting stations, hospitals and hotels, funeral homes, public and recreational buildings, department and drug stores, theaters, manufacturing plants of many kinds, and fur storage establishments.

Copies of the report are available from the EEI for $1.00.

Sunshine Is Wonderful—Outdoors

Les Avery, President of Avery Engineering, Reports Study of One Method of Reducing the Solar Heat Through Windows

SUMMARY

Sunshine is wonderful outdoors, but to the air conditioning engineer at least it presents a problem inside buildings. It affects plant capacity, operating cost and zoning. . . . Most recent development in methods of reducing solar heat gain through windows is a sun screen made of fine mesh bronze; the horizontal wires are small flat strips spaced 17 to the inch and held in such manner as to prevent the passage of direct solar rays at angles of 38½ deg and over. . . . To see how effective the method is, the author made some studies of temperatures in an air conditioned office suite for windows both with and without the sun screen. The results of his informal survey are summarized here

SUNSHINE is wonderful—outdoors. But sunshine inside is something else again—at least to the air conditioning engineer. He must plan on the heat load that comes from the sun as a definite factor affecting plant capacity and operating cost. Sun load also requires zoning in buildings exposed to sunshine; a cooling system designed to operate satisfactorily on the shady side of the building would be under capacity when exposed to sunshine in ordinary summer weather.

Methods of reducing the solar heat gain of buildings are therefore of intense and practical interest to air conditioning people. Most recent development in this field is a sun screen made of fine mesh bronze and designed so as to prevent the passage of solar rays. In order to determine some of the operating characteristics of this sun screen we arranged a test in a suite of offices in Cleveland. Our intent was not to make a complete engineering analysis of heat gain or comparison of various sun protecting devices, but rather to secure results of interest to the designing engineer who wants to use sun protecting devices, and wonders how the sun screen performs.

Various test readings were taken at different times during the month of May and early part of June and two sets of readings are shown on the next page. The readings for Sunday, June 9, were taken with the office ventilating and air conditioning system turned off and with the windows shut. Readings for June 10 were taken with the office air conditioning system running and show considerably lower temperatures in the sunlight, as would be expected.

A thermometer exposed to sunshine is affected by two separate and distinct influences. First, the sun radiant temperature is accepted or reflected, depending on the quality of blackness of the thermometer. In this case we had dial thermometers close to the windows, which showed the temperatures at this point. The three recording thermometers, 2 ft inside the windows, showed somewhat different temperatures. Part of the difference is due to location, but more essentially to the amount of re-radiation and conduction losses from the thermometer proper to the surrounding room air. This can be shown very

Solar Radiation (in Btu per Sq Ft per Hr) Transmitted Through Windows With and Without Sun Screen for 30 and 35 Deg Latitudes, on July 21

(See Notes at Bottom of Table)

	SUN TIME A.M.	SOLAR RADIATION	NE ←	E ←	SE ←	S ←→	SW →	W →	NW →	SUN TIME P.M.
30 Deg Lat	6:00	Intensity Incident to Vertical Surface	47	51	24	.....	24	51	47	6:00
		Transmitted thru Single Window Glass-Bare	48	52	22	.....	22	52	48	
		Transmitted thru Window with Sun Screen	24	26.5	9	.....	9	26.5	24	
	7:00	Intensity Incident to Vertical Surface	136	160	90	.....	90	160	136	5:00
		Transmitted thru Single Window Glass-Bare	122	147	77	.....	77	147	122	
		Transmitted thru Window with Sun Screen	42	57	17	.....	17	57	42	
	8:00	Intensity Incident to Vertical Surface	151	205	136	.....	136	205	151	4:00
		Transmitted thru Single Window Glass-Bare	140	190	116	.....	116	190	140	
		Transmitted thru Window with Sun Screen	21	42	15.5	.....	15.5	42	21	
	9:00	Intensity Incident to Vertical Surface	127	189	140	8	140	189	127	3:00
		Transmitted thru Single Window Glass-Bare	101	170	118	1	118	170	101	
		Transmitted thru Window with Sun Screen	10	21	12	0	12	21	10	
	10:00	Intensity Incident to Vertical Surface	79	141	122	31	122	141	79	2:00
		Transmitted thru Single Window Glass-Bare	43	116	95	8	95	116	43	
		Transmitted thru Window with Sun Screen	4	11.5	8.5	0.5	8.5	11.5	4	
	11:00	Intensity Incident to Vertical Surface	21	78	85	45	85	78	21	1:00
		Transmitted thru Single Window Glass-Bare	2	40	53	17	53	40	2	
		Transmitted thru Window with Sun Screen	0.5	3.5	4	1.5	4	3.5	0.5	
	12:00	Intensity Incident to Vertical Surface	.....	.....	36	50	36	.....	.....	12:00
		Transmitted thru Single Window Glass-Bare	.....	.....	10	20	10	.....	.....	
		Transmitted thru Window with Sun Screen	.....	.....	1	1.5	1	.....	.....	
35 Deg Lat	6:00	Intensity Incident to Vertical Surface	67	72	35	.....	35	72	67	6:00
		Transmitted thru Single Window Glass-Bare	48	52	23	.....	23	52	48	
		Transmitted thru Window with Sun Screen	32.5	36	12	.....	12	36	32.5	
	7:00	Intensity Incident to Vertical Surface	142	174	103	.....	103	174	142	5:00
		Transmitted thru Single Window Glass-Bare	118	147	81	.....	81	147	118	
		Transmitted thru Window with Sun Screen	41	59	19.5	.....	19.5	59	41	
	8:00	Intensity Incident to Vertical Surface	150	209	145	.....	145	209	150	4:00
		Transmitted thru Single Window Glass-Bare	130	187	126	.....	126	187	130	
		Transmitted thru Window with Sun Screen	19.5	42	17.5	.....	17.5	42	19.5	
	9:00	Intensity Incident to Vertical Surface	118	191	154	26	154	191	118	3:00
		Transmitted thru Single Window Glass-Bare	86	170	132	6	132	170	86	
		Transmitted thru Window with Sun Screen	9.5	21	14	0.5	14	21	9.5	
	10:00	Intensity Incident to Vertical Surface	60	143	139	55	139	143	60	2:00
		Transmitted thru Single Window Glass-Bare	27	116	113	24	113	116	27	
		Transmitted thru Window with Sun Screen	2.5	11.5	11	2	11	11.5	2.5	
	11:00	Intensity Incident to Vertical Surface	2	75	103	72	103	75	2	1:00
		Transmitted thru Single Window Glass-Bare	.....	40	73	39	73	40	.....	
		Transmitted thru Window with Sun Screen	.....	4	6	3	6	4	.....	
	12:00	Intensity Incident to Vertical Surface	.....	.....	55	78	55	.....	.....	12:00
		Transmitted thru Single Window Glass-Bare	.....	.....	23	46	23	.....	.....	
		Transmitted thru Window with Sun Screen	.....	.....	2	4	2	.....	.....	

Data on intensity incident to vertical surface reprinted by permission from Heating, Ventilating, Air Conditioning Guide 1940, Chapt. 8.

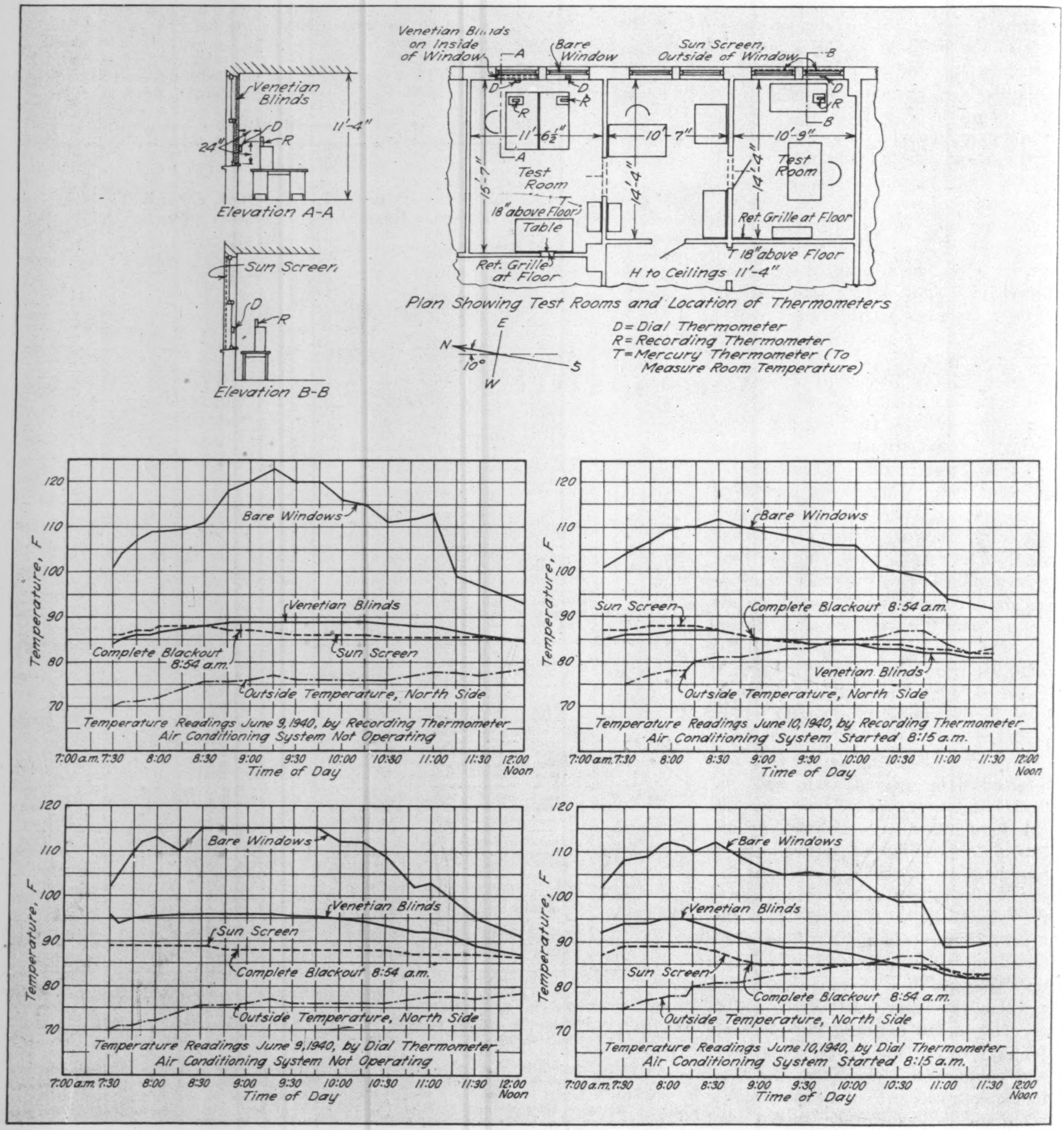
Data on transmission through single window glass from Figuring Solar Heat Gains of Buildings, by William Goodman, HEATING, PIPING AND AIR CONDITIONING, May and June, 1938. Copyright by author.

Data on transmission through sun screen from calculations made by Pittsburgh Testing Laboratory, based on their tests for the manufacturer. These data represent solar heat gain through windows *in excess* of heat gain by conduction through glass (as do the data for bare windows), total heat gain being determined by adding the value of heat gain by conduction. Data reproduced by courtesy of Ingersoll Steel & Disc Div., Borg-Warner Corp.

easily by taking any thermometer and putting it in the sunlight, and then directing a current of air over it. The lower temperature readings on June 10 indicate the cooling effect of the office air conditioning system on the thermometers themselves.

The office windows faced approximately east and it is interesting that although the sun partially penetrated through the sun screen until 8:54 a. m., June 10, the thermometers back of the screen showed very little increase in temperature. In effect we have what might be called "cool sunshine"; that is, sunshine strong enough to throw a shadow, but which does not feel hot to the skin or a thermometer.

Any one who has used venetian blinds on an east or west exposure is aware of the "panel heating effect" which comes when the blinds are closed against the sunlight. This has long been known to the air conditioning engineer and has been one problem that cannot be successfully solved by lowering the temperature in the room. Panel heating affects those close by and in small offices panel heating of venetian blinds is a problem—so much so that (in the offices studied) in previous summers the air cooling system was unable to pick up the accumulated sun heat load and make a comfortable office until 11:00 or 12:00 o'clock. This panel heating effect has been entirely eliminated from the office equipped with the sun screen and the cooling system is well able to handle the load starting at the usual 8:30 a. m. operating period.



The subject of solar radiation is a complicated one, as not only the direct rays of the sun but the reflected rays that come from all directions toward any opening must be considered. The walls of a building opposite a window may be radiating a great deal of heat, although the window in question is not exposed directly to sunlight. Reflected radiant heat from pavement introduces an additional heating load to low windows.

Our findings in this little study confirm the opinion of many engineers that the subject of solar radiation must be carefully tested and analyzed. It should be worthwhile to run very complete comparative tests on east and west exposures as well as south exposures using the various methods and devices for protecting against sunlight, so that these could be directly compared and the heat gain figured more accurately than is now possible. What color and finish on awnings and venetian blinds? What color and material on shades? What about sun screen, heat absorbing glass, standard or special glass block? From our observations it appears that the sun screen is a heat absorber, and as such is efficient because it is on the outside of the building, stops the radiant heat, converts it to sensible heat which is diffused to the outside air and thus does not enter the room. The angle of the sun screen wire is important; the design is on the basis of admitting sufficient light and permitting clear vision.

Solar Radiation (in Btu per Sq Ft per Hr) Transmitted Through Windows With and Without Sun Screen for 40 and 45 Deg Latitudes, on July 21

(See Notes at Bottom of Table)

	SUN TIME A.M.	SOLAR RADIATION	NE ←	E ←	SE ←	S ←→	SW →	W →	NW →	SUN TIME P.M.
40 Deg Lat	6:00	Intensity Incident to Vertical Surface	72	80	40	.....	40	80	72	6:00
		Transmitted thru Single Window Glass-Bare	47	52	24	.....	24	52	47	
		Transmitted thru Window with Sun Screen	33	38.5	13	.....	13	38.5	33	
	7:00	Intensity Incident to Vertical Surface	143	180	112	.....	112	180	143	5:00
		Transmitted thru Single Window Glass-Bare	114	147	86	.....	86	147	114	
		Transmitted thru Window with Sun Screen	38.5	60.5	22	.....	22	60.5	38.5	
	8:00	Intensity Incident to Vertical Surface	143	211	155	8	155	211	143	4:00
		Transmitted thru Single Window Glass-Bare	120	190	124	1	124	190	120	
		Transmitted thru Window with Sun Screen	17	42.5	20.5	0	20.5	42.5	17	
	9:00	Intensity Incident to Vertical Surface	104	192	168	46	168	192	104	3:00
		Transmitted thru Single Window Glass-Bare	71	170	146	18	146	170	71	
		Transmitted thru Window with Sun Screen	8	22	17	2	17	22	8	
	10:00	Intensity Incident to Vertical Surface	46	143	156	77	156	143	46	2.00
		Transmitted thru Single Window Glass-Bare	15	116	132	45	132	116	15	
		Transmitted thru Window with Sun Screen	1.5	11.5	13	4	13	11.5	1.5	
	11:00	Intensity Incident to Vertical Surface	.....	75	121	95	121	75	.....	1:00
		Transmitted thru Single Window Glass-Bare	.....	40	93	66	93	40	.....	
		Transmitted thru Window with Sun Screen	.....	3.5	8.5	5.5	8.5	3.5	.....	
	12:00	Intensity Incident to Vertical Surface	.....	.....	73	103	73	.....	.....	12:00
		Transmitted thru Single Window Glass-Bare	.....	.....	40	74	40	.....	.....	
		Transmitted thru Window with Sun Screen	.....	.....	3.5	6	3.5	.....	.....	
45 Deg Lat	6:00	Intensity Incident to Vertical Surface	89	99	52	.....	52	99	89	6:00
		Transmitted thru Single Window Glass-Bare	46	52	25	.....	25	52	46	
		Transmitted thru Window with Sun Screen	39	45.5	15.5	.....	15.5	45.5	39	
	7:00	Intensity Incident to Vertical Surface	149	194	125	.....	125	194	149	5:00
		Transmitted thru Single Window Glass-Bare	109	147	91	.....	91	147	109	
		Transmitted thru Window with Sun Screen	37	64	25	.....	25	64	37	
	8:00	Intensity Incident to Vertical Surface	140	219	171	22	171	219	140	4:00
		Transmitted thru Single Window Glass-Bare	110	190	145	4	145	190	110	
		Transmitted thru Window with Sun Screen	15.5	45	25	0.5	25	45	15.5	
	9:00	Intensity Incident to Vertical Surface	92	194	183	65	183	194	92	3:00
		Transmitted thru Single Window Glass-Bare	57	170	160	33	160	170	57	
		Transmitted thru Window with Sun Screen	6.5	23	20	3.5	20	23	6.5	
	10:00	Intensity Incident to Vertical Surface	33	144	171	98	171	144	33	2:00
		Transmitted thru Single Window Glass-Bare	6	116	149	69	149	116	6	
		Transmitted thru Window with Sun Screen	1	11.5	15.5	6.5	15.5	11.5	1	
	11:00	Intensity Incident to Vertical Surface	.....	75	139	121	139	75	.....	1:00
		Transmitted thru Single Window Glass-Bare	.....	40	112	93	112	40	.....	
		Transmitted thru Window with Sun Screen	.....	4	10.5	8.5	10.5	4	.....	
	12:00	Intensity Incident to Vertical Surface	.....	.....	91	128	91	.....	.....	12:00
		Transmitted thru Single Window Glass-Bare	.....	.....	59	102	59	.....	.....	
		Transmitted thru Window with Sun Screen	.....	.....	5	9	5	.....	.....	

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Data on transmission through single window glass from Figuring Solar Heat Gains of Buildings, by William Goodman, HEATING, PIPING AND AIR CONDITIONING, May and June, 1938. Copyright by author.

Data on transmission through sun screen from calculations made by Pittsburgh Testing Laboratory, based on their tests for the manufacturer. These data represent solar heat gain through windows *in excess* of heat gain by conduction through glass (as do the data for bare windows), total heat gain being determined by adding the value of heat gain by conduction. Data reproduced by courtesy of Ingersoll Steel & Disc Div., Borg-Warner Corp.

Direct Fired Units Heat Armor Plate Plant

By David Henderson*

An adjustment to potential defense needs is seen in the rehabilitation of the navy's armor plate plant at South Charleston, W. Va. This plant was built during the last war but has stood idle until the recent reconditioning was undertaken.

The plant was originally served by a number of small coal fired boilers; these had been removed and only the building which had housed them remained. Two 90,000 lb per hr, 250 lb pressure boilers, fired with natural gas, are being installed. The boiler plant will provide steam required for the operation of giant presses. The gas burners are arranged for future adaptation to oil burning.

A feature in the rehabilitation of this plant is the segregation of the large machine shop from the boiler house insofar as heating is concerned. Since gas is used to fire the boilers, it was deemed advisable to use it for the direct fired unit air heaters to heat the machine shop. This means that it will be possible to operate and heat the machine shop without operating the boiler plant. The large size of the machine shop was another factor in this decision. The shop is 500 ft long, 300 ft wide and 70 ft high.

A total of 22 floor type air heaters, rated at 1,000,000 Btu per hr output each, are to be installed. The heaters will be arranged along the outside of the shop so that cold air will be taken from the floor by the fans of the units and blown up past the heating elements. The temperature of the air will be raised in the heater about 80 deg. The heated air will then be discharged in a horizontal manner toward the center of the shop.

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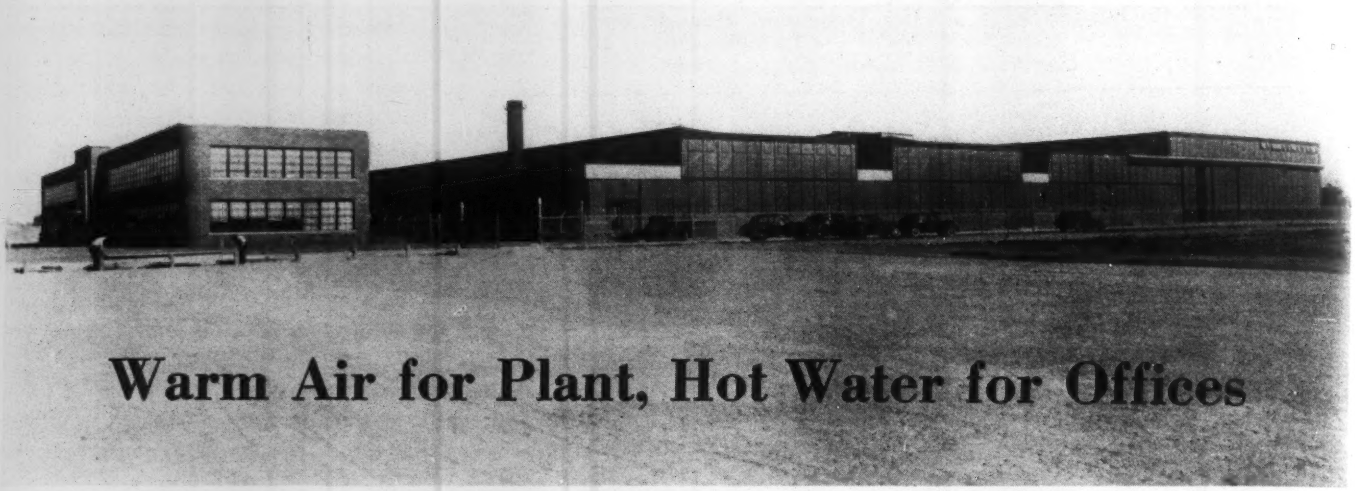
*Engineer, Machinery Div., Dravo Corp.



Warm Air for Plant, Hot Water for Offices

NEED for increased manufacturing facilities fostered by the demand for commercial and military aircraft necessitated building a new plant to augment Aviation Mfg. Corp. facilities at Wayne, Mich., (Stinson) and Williamsport, Pa. (Lycoming engines and propellers.) Nashville was selected for the site because of its inland location and other favorable factors.

The problem encountered by Albert Kahn, Inc., the architects and engineers, was the sub-assembly and final assembly of smaller airplanes on a group basis, for which the principal requirements were clear manufacturing space, uniform daylighting and flexibility of design to permit economical expansion in either the sub-assembly departments or the main assembly section. In addition to immediate requirements, consideration had to be given to provision of ample manufacturing space for the largest type of aircraft production and abundant space for constructing larger types as they are developed. The plant consists of a 122,914 sq ft factory building with a 20,228 sq ft office building, auxiliary buildings consisting of a paint shop, paint storage, wood shop and hammer room, and a sand blasting unit situated between the fabricating department in the main building and the paint shop.

The factory is heated by a circulating air system and during all seasons of the year filtered air is supplied. The warm air is distributed by means of underground concrete ducts, with flush type outlets in the floor along the outside walls and column type outlets at the base of the center building columns. Excessive infiltration is counteracted at the large sliding doors in the assembly department by a curtain of warm air which rises from a full length, grille covered duct in the floor at the foot of the doors.

The system is so arranged that outside air, recirculated air or both can be returned to the heater rooms through return air openings on the floor line at each of these rooms. The two 60,000 cfm brick set, tubular, direct fired, warm air heaters are each capable of delivering 6,200,000 Btu per hr, and have an overload capacity of 20 per cent for short and warming up periods. The heaters are stoker fired and are situated in pits below the floor level, one at the northwest corner and the other at the southeast corner.

The location and area of the pivoted sash ventilators in the sides of the building and roof monitor are designed to allow for control of air and ventilation under normal circumstances. The sash in the west and south elevations, including the south sides of monitors, are glazed with a non-glare, heat resisting glass. During the summer and early fall it is expected this will keep temperatures inside the building several degrees cooler than would otherwise be the case.

The air conditioning system for the administration building consists of a unit in the basement area furnishing conditioned air to the first and second floors. The unit is equipped with air filters, cooling and heating coils, and an air washer in which direct expansion coils are installed.

The method of cooling the condenser water is somewhat unusual. For fire protection purposes there is a large underground storage reservoir. Condenser water is pumped from the bottom of this reservoir through the condensers and returned to a series of sprays on the reservoir roof. Holes in the roof permit the water to return to the reservoir. During the night, when the air conditioning system is not in operation, the condenser water pump can be used for pumping the water from the reservoir through the sprays in order to reduce the water temperature in anticipation of the next day's requirements.

The administration building is heated by a combination of forced circulation hot water radiation and forced air, the heating elements of the air system being supplied from the hot water mains. The air is put into the building at room temperature and the hot water is supplied to the radiators at a proper temperature to overcome the heat losses only. The temperature of this hot water is governed by a control with one bulb mounted outside and the other in the hot water supply to the building.

The water for the system is heated by means of a stoker fired welded steel, hot water boiler in the same pit as the factory heating plant.

The hot water mains run overhead through the factory and across a connecting passage to the basement of the office building, where branches are taken off to supply the heating coils in the ventilating system before rising to the first floor ceiling where the mains are run above the suspended ceiling to supply the radiators in the offices.

The Air Conditioning Contractor

John H. Carter* Points Out the Value of Using Cost Estimating Sheets, Tells How Selling Price Is Found

SUMMARY

By Request

An organization which takes the time to fill in an extremely detailed estimating form does not have to load up the mark-up with an indeterminate allowance for bad guessing, or "miscellaneous." It is safe to assume that very little will be overlooked after such forms have been completely filled out, and that is the main reason for their use. . . . . On the larger jobs, usual practice is to get the total installed cost and then add a mark-up which is to consist of overhead, sales cost, service and profit. Where the organization is experienced and the job is of the accustomed type and size, the selling price can safely be determined by taking the total cost and adding an averaged mark-up percentage. For the less experienced contracting organization, or for the pricing of a job of unusual type, it is suggested that individual mark-ups be added horizontally to each detailed item of cost. Each cost item can be marked up by a fixed percentage covering overhead, sales and profit and then by a varying percentage representing the risk or uncertainty involved. . . . . This article is the third on various phases of the air conditioning contracting business written by Mr. Carter in answer to a request of a regular reader of HPAC, who was recently given the job of re-organizing one of the oldest heating, ventilating and air conditioning contracting companies in the country

I SUPPOSE that absolute zero in reader interest is reached by an article on business management, especially when the business is somebody else's, and when the illustrations consist of printed forms. Accordingly I doubt if any of the air conditioning contractor's customers or potential customers will have persisted this far in this little series of articles. The more discriminating readers no doubt have noticed that these articles have carefully avoided mentioning any specific costs or expense percentages. If any customers happen to be reading this, however, and if they have the idea that mark-ups in air conditioning are too high, they are invited to contemplate two points. The first is the mortality rate in the air conditioning contracting business; the other is the method of estimating used (with certain modifications) by most well-run engineering-contracting organizations. It should be quite apparent that any organization which takes the trouble to fill in an extremely detailed estimating form, calculating costs down to the fraction of a per cent in the aggregate, does not have to load the mark-up with an indeterminate allowance for bad guessing, or "miscellaneous." (The customer will also notice, I hope, what a lot of work goes into making an estimate.)

The cost estimating sheets reproduced on the next two pages have been furnished through the kindness of two air conditioning contractors, B-D-R Engineering Corp. and Mid State Engineering Co.

It is safe to assume that there will have been very little overlooked by the time either of these forms has been completely filled out. That is the main reason for their use. An estimator of great experience and mental capacity can probably get along all right with just a pad of paper, but the average engineering estimator of moderate experience will be greatly benefited by an organized guide to completeness and orderly analysis, such as estimating forms of this kind provide. It is useful to have a blank column just beside the "estimated cost" column, so that actual costs can later be entered.

In the contracting of larger jobs, the usual practice is to get the total installed cost, and then add a mark-up which is to consist of overhead, sales cost, service (if "free") and profit. My earlier articles have covered in a somewhat general way the matter of overhead, which is added in percentage form and is usually based upon the ratio of total yearly overhead expense to estimated yearly sales volume. Sales cost will also usually be expressed as a percentage. Service is sometimes based upon an estimated percentage, but in the case of a job of unusual type or size it might be figured in detail and expressed in dollars. It would be useless for me to offer any suggestions as to profit mark-up, except to say that there ought to be one.

There is no such thing, of course, as "free service." Some allowance is always made for it in the price. It represents a gamble on the part of the contractor, but normally and properly he does not take much of an unknown risk in this possibility if he knows his business and his product.

Where the organization is experienced and the job is of accustomed type and size, the selling price can safely be determined by taking the total cost and adding an average mark-up percentage. For the less experienced contracting organization, or for the pricing of a job of very unusual type, I would diffidently offer the suggestion that individual mark-ups be added horizontally to each detailed item of cost. Each cost item can be marked up by a fixed percentage covering overhead, sales and profit, and then by a varying percentage representing the risk or uncertainty involved by the application of that item. This method will make a separate service estimate unnecessary, since costs of service will have been included in the itemized mark-ups. The total of the marked-up costs will represent a weighted mark-up, with due emphasis given unusual features of the job.

[*Earlier articles by Mr. Carter in the March and May issues have discussed other phases of the air conditioning contracting business.*]

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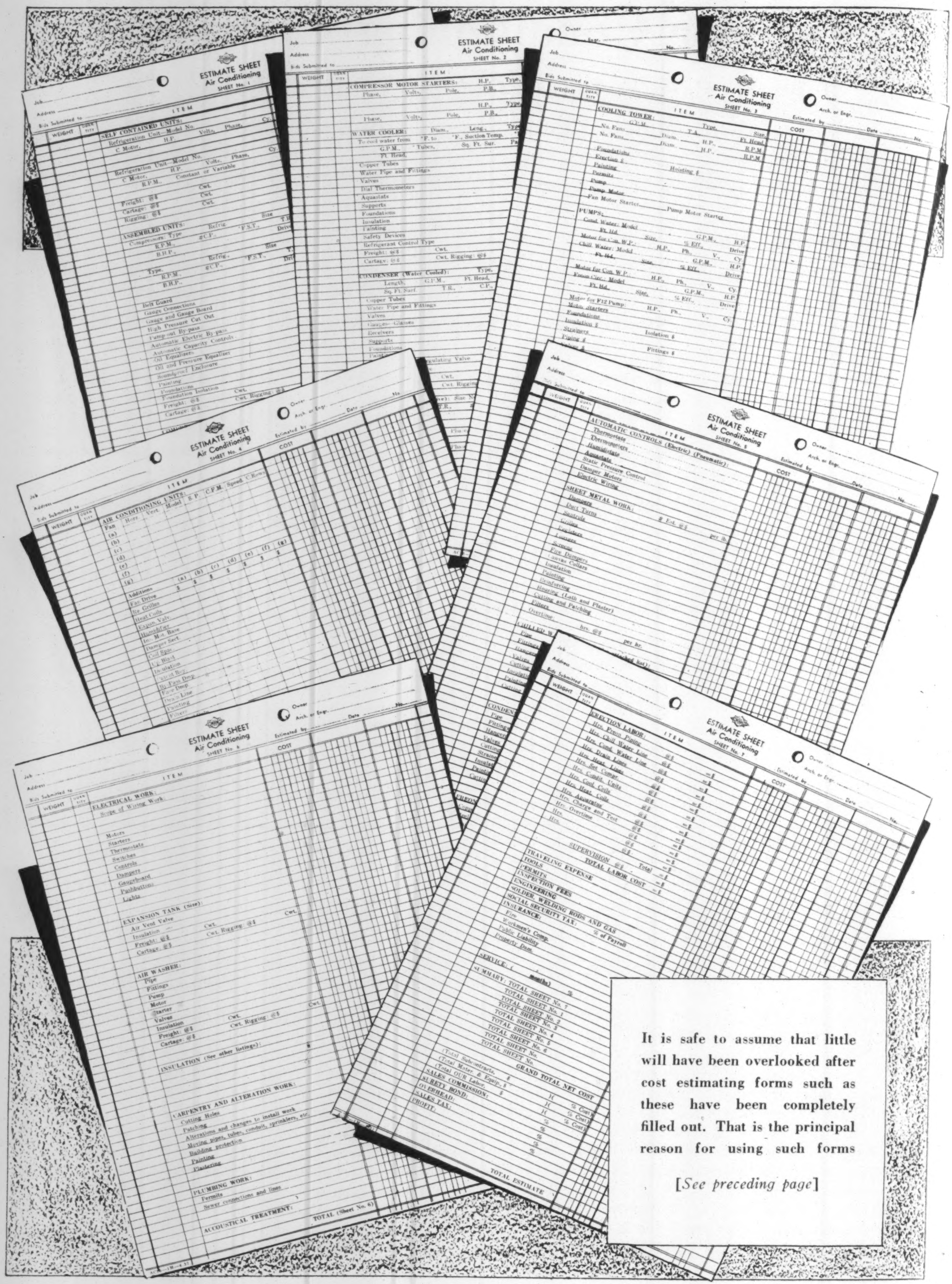
*Kupferle-Hicks Heating Co.



ESTIMATE SHEET
Air Conditioning
SHEET No. 1

Job
Address
Bids Submitted to

WEIGHT | QUANTITY | ITEM

SELF CONTAINED UNITS:
Refrigeration Unit—Model No. Volts, Phase, Cy.
C Motor, H.P.

Refrigeration Unit—Model No. Volts, Phase, Cy.
C Motor, H.P. Constant or Variable
R.P.M.,
Freight: @$ Cwt.
Cartage: @$ Cwt.
Rigging: @$ Cwt.

ASSEMBLED UNITS:
Compressors: Type Refrig. °F.S.T., Size T.R.
R.P.M., #C.P., Drive
B.H.P.,
Type, Refrig. °F.S.T., Size T.
R.P.M., #C.P., Dri
B.H.P.,

Belt Guard
Gauge Connections
Gauge and Gauge Board
High Pressure Cut Out
Pump-out By-pass
Automatic Electric By-pass
Automatic Capacity Controls
Oil Equalizers
Oil and Pressure Equalizer
Soundproof Enclosure
Painting
Foundations
Foundation Isolation
Freight: @$ Cwt.
Cartage: @$ Cwt. Rigging: @$

ESTIMATE SHEET
Air Conditioning
SHEET No. 2

Job
Address
Bids Submitted to

WEIGHT | QUANTITY | ITEM

COMPRESSOR MOTOR STARTERS: H.P., Type,
Phase, Volts, Pole, P.B.,
H.P., Type,
Phase, Volts, Pole, P.B.,

WATER COOLER: Diam., Leng., Type
To cool water from °F. to °F., Suction Temp.
G.P.M., " Tubes, Sq. Ft. Sur.
Ft. Head,
Copper Tubes
Water Pipe and Fittings
Valves
Dial Thermometers
Aquastats
Supports
Foundations
Insulation
Painting
Safety Devices
Refrigerant Control Type
Freight: @$ Cwt.
Cartage: @$ Cwt. Rigging: @$

CONDENSER (Water Cooled): Type,
Length, G.P.M., Ft. Head,
Sq. Ft. Surf. T.R., C.P.,
Copper Tubes
Water Pipe and Fittings
Valves
Gauges—Glasses
Receivers
Supports
Foundations
Painting
Regulating Valve
Cwt.
Cwt. Rigging
Size N
T.R.,

ESTIMATE SHEET
Air Conditioning
SHEET No. 3

Job
Address
Bids Submitted to
Owner
Arch. or Engr.
Estimated by
Date
No.

WEIGHT | QUANTITY | ITEM | COST

COOLING TOWER:
G.P.M. Type,
No. Fans Diam., T.A. Size,
No. Fans Diam., H.P., Ft. Head,
H.P., R.P.M.
R.P.M.
Foundations
Erection $ Hoisting $
Painting
Permits
Pump
Pump Motor
Fan Motor Starter Pump Motor Starter

PUMPS:
Cond. Water: Model
Ft. Hd. Size, G.P.M., H.P.
Motor for Con. W.P.: % Eff., Drive
H.P., Ph., V., Cy.
Chill Water: Model
Ft. Hd. Size, G.P.M., H.P.
% Eff., Drive
Motor for Con. W.P.: H.P., Ph., V., Cy.
Freon Circ.: Model
Ft. Hd. Size, G.P.M., H.P.
% Eff., Drive
Motor for F12 Pump: H.P., Ph., V., Cy.
Motor Starters
Foundations
Insulation $
Strainers Isolation $
Piping $
Valves $ Fittings $

ESTIMATE SHEET
Air Conditioning
SHEET No. 4

Job
Address
Bids Submitted to
Owner
Arch. or Engr.
Estimated by
Date
No.

WEIGHT | QUANTITY | ITEM | COST

AIR CONDITIONING UNITS:
Fan Horz. Vert. Model S.P. C.F.M. Speed C.Rows
(a)
(b)
(c)
(d)
(e)
(f)
(g)
Additions (a) $ (b) $ (c) $ (d) $ (e) $ (f) $ (g) $
Fan Drive
Re Grilles
Heat Coils
Expan. Valv.
Humidifier
Ins. Mot. Base
Damper Sect.
Coil Spac.
Up Blast
Insulation
Patent Roy.
By-Pass Dmp
Face Dmp
Drain Line
Painting
Filters

ESTIMATE SHEET
Air Conditioning
SHEET No. 5

Job
Address
Bids Submitted to
Owner
Arch. or Engr.
Estimated by
Date
No.

WEIGHT | QUANTITY | ITEM | COST

AUTOMATIC CONTROLS (Electric) (Pneumatic):
Thermostats
Thermometers
Humidistats
Aquastats
Static Pressure Control
Damper Motors
Electric Wiring

SHEET METAL WORK:
Dampers
Duct Turns $ Est. @$
Sautrols per lb.
Grilles
Registers
Louvers
Screens
Fire Dampers
Canvas Collars
Insulation
Painting
Reinforcing
Housing (Lath and Plaster)
Cutting and Patching
Filters
Overtime: hrs. @$ per hr.

CHILLED W
Pipe
Fittings
Hangers
Valves
Cutting
Insulation
Painting
Cutting

CONDEN
Pipe
Fittings
Hangers
Valves
Cutting
Strainers
Insulation
Painting
Cutting

FREON
Copper

ESTIMATE SHEET
Air Conditioning
SHEET No. 6

Job
Address
Bids Submitted to
Owner
Arch. or Engr.
Estimated by
Date
No.

WEIGHT | QUANTITY | ITEM | COST

ELECTRICAL WORK:
Scope of Wiring Work
Motors
Starters
Thermostats
Switches
Controls
Dampers
Gaugeboard
Pushbuttons
Lights

EXPANSION TANK (Size): Cwt.
Air Vent Valve
Insulation Cwt.
Freight: @$ Cwt. Rigging: @$
Cartage: @$

AIR WASHER:
Pipe
Fittings
Pump
Motor
Starter Cwt.
Valves
Insulation Cwt.
Freight: @$ Cwt. Rigging: @$
Cartage: @$

INSULATION (See other listings):

CARPENTRY AND ALTERATION WORK:
Cutting Holes
Patching
Alterations and changes to install work
Moving pipes, tubes, conduit, sprinklers, etc.
Building protection
Painting
Plastering

PLUMBING WORK:
Permits
Sewer connections and lines

ACCOUSTICAL TREATMENT:
TOTAL (Sheet No. 6)

ACR—1M—4-37

ESTIMATE SHEET
Air Conditioning
SHEET No. 7

Job
Address
Bids Submitted to
Owner
Arch. or Engr.
Estimated by
Date
No.

WEIGHT | QUANTITY | ITEM | COST

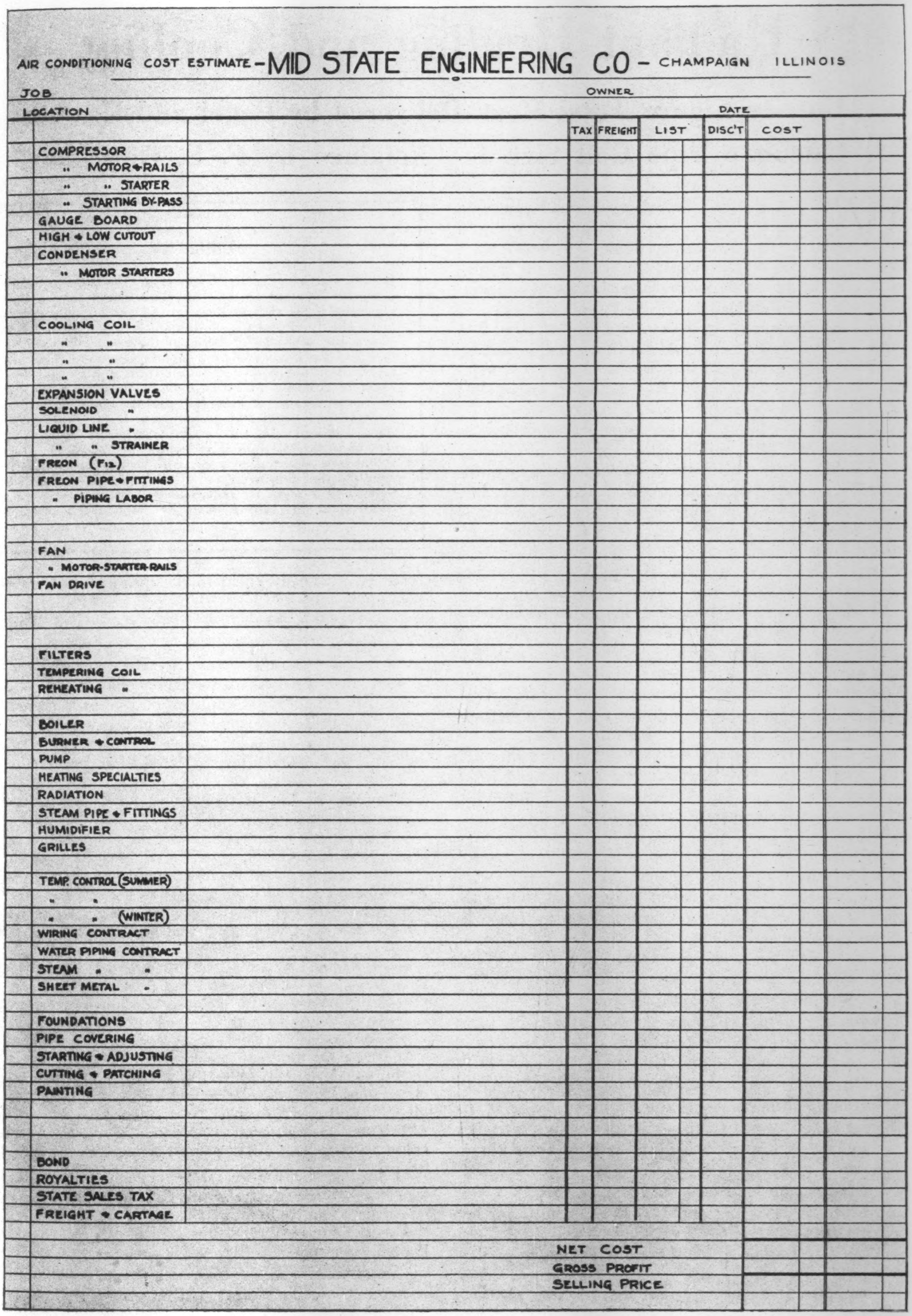
ERECTION LABOR:
Hrs. Freon Piping @$ =$
Hrs. Chill Water Line @$ =$
Hrs. Cond. Water Line @$ =$
Hrs. Drain Lines @$ =$
Hrs. Heat. Lines @$ =$
Hrs. Set Compr. @$ =$
Hrs. Condit. Units @$ =$
Hrs. Cool. Coils @$ =$
Hrs. Heat. Coils @$ =$
Hrs. Apparatus @$ =$
Hrs. Charge and Test @$ =$
Hrs. Overtime @$ =$
Hrs. @$ =$
SUPERVISION @$ Total =$
TOTAL LABOR COST =$
TRAVELING EXPENSE
TOOLS
PERMITS
INSPECTION FEES
ENGINEERING
SOLDER, WELDING RODS AND GAS
SOCIAL SECURITY TAX: % of Payroll
INSURANCE:
Fire
Workmen's Comp.
Public Liability
Property Dam.

SERVICE: (months)

SUMMARY: TOTAL SHEET No. 7 %
TOTAL SHEET No. 1
TOTAL SHEET No. 2
TOTAL SHEET No. 3
TOTAL SHEET No. 4
TOTAL SHEET No. 5
TOTAL SHEET No. 6
TOTAL SHEET No.
GRAND TOTAL NET COST
(Total Subcontracts, $)(% Cost)
(Total Mater. & Equip. $)(% Cost)
(Total OUR Labor, $)(% Cost)
SALES COMMISSION: %
SURETY BOND: %
OVERHEAD: %
SALES TAX: %
PROFIT:
TOTAL ESTIMATE

It is safe to assume that little will have been overlooked after cost estimating forms such as these have been completely filled out. That is the principal reason for using such forms

[See preceding page]



AIR CONDITIONING COST ESTIMATE – MID STATE ENGINEERING CO – CHAMPAIGN ILLINOIS

JOB

OWNER

LOCATION

DATE

		TAX	FREIGHT	LIST	DISC'T	COST	
COMPRESSOR							
" MOTOR & RAILS							
" " STARTER							
" STARTING BY-PASS							
GAUGE BOARD							
HIGH & LOW CUTOUT							
CONDENSER							
" MOTOR STARTERS							
COOLING COIL							
" "							
" "							
" "							
EXPANSION VALVES							
SOLENOID "							
LIQUID LINE "							
" " STRAINER							
FREON (F_{12})							
FREON PIPE & FITTINGS							
" PIPING LABOR							
FAN							
" MOTOR-STARTER-RAILS							
FAN DRIVE							
FILTERS							
TEMPERING COIL							
REHEATING "							
BOILER							
BURNER & CONTROL							
PUMP							
HEATING SPECIALTIES							
RADIATION							
STEAM PIPE & FITTINGS							
HUMIDIFIER							
GRILLES							
TEMP. CONTROL (SUMMER)							
" "							
" " (WINTER)							
WIRING CONTRACT							
WATER PIPING CONTRACT							
STEAM " "							
SHEET METAL "							
FOUNDATIONS							
PIPE COVERING							
STARTING & ADJUSTING							
CUTTING & PATCHING							
PAINTING							
BOND							
ROYALTIES							
STATE SALES TAX							
FREIGHT & CARTAGE							
	NET COST						
	GROSS PROFIT						
	SELLING PRICE						

Radiant Heating and Cooling

How to Figure Total Heat Delivered by Panel and How to Calculate Pipe Coil Size Is Explained by F. E. Giesecke*

SUMMARY

Previous articles by Dr. Giesecke in the June and July issues of HEATING, PIPING AND AIR CONDITIONING have explained what radiant heating and cooling mean, have given the fundamentals of design of such systems, have shown the relationship between the room air temperature and the mean radiant temperature of the room surfaces, discussed heat dissipation from a pipe coil in a concrete slab, etc. . . . . This month, he tells us how to figure the amount of heat delivered by a ceiling, wall or floor heating panel and presents a rule for this calculation. He concludes with an explanation of figuring the size of pipe coil needed and shows an example of the calculation of a ceiling panel coil. . . . The two charts simplify the determination of the amount of heat delivered to a room by radiation, and by convection and conduction, by ceiling, wall or floor heating panels

WHEN a room is heated by a panel placed in the ceiling, wall or floor, this panel forms a part of the surfaces enclosing the room and it may be assumed to be entirely enclosed by the room's surfaces. The heat transmitted by such a panel by radiation to the remaining portion of the room's surfaces may therefore be calculated by means of Equation 2, p. 360, June, 1940, HPAC. To avoid the necessity of making such calculations, the heat delivered by a panel by radiation may be taken from Fig. 1, as follows: To find the heat delivered by a heating panel when its temperature is 90 F, for example, to a room having a mean radiant temperature of 70 F for its enclosing surfaces, except the heating panel, find 90 in the lower margin, follow vertically up to the 70 F mean radiant temperature line, and on the left margin read about 19.5 Btu. Similarly, if the panel surface temperature is 105 F and the mean radiant surface temperature is 75 F, the rate of heat delivery by radiation is about 31 Btu per sq ft per hr, according to Fig. 1.

A heating panel delivers heat by radiation and by convection. The rate of heat delivery by convection depends upon the film coefficient; this varies with the velocity of the flow of air along the heated panel and also with the difference between the temperature of the panel and that of the adjacent air. Of three heating panels placed in the ceiling, wall, and floor, respectively, the film coefficient is evidently highest for the floor panel, because the heated air escapes readily from the floor, and lowest for the ceiling panel, because the heated air tends to remain stationary along the ceiling.

According to European research and experience (as reported by Max Hottinger of the Zurich Engineering School in *Gesundheits-Ingenieur,* 1938, Vol. 61, Nos. 33 and 34), the film coefficient may be selected with sufficient accuracy from the chart of Fig. 2. Thus, if the surface temperatures are, respectively, 80 F for a floor panel, 90 F for a wall panel and 105 F for a ceiling panel, while the air temperature is 68 F, the respective temperature differences are 12, 22 and 37 deg and the corresponding film coefficients are 0.90, 0.84 and 0.56 Btu per sq ft per hr per F from Fig. 2.

For these same temperature differences (80—68, 90—68 and 105—68) the heat delivered by radiation is 11.4, 21.5 and 37.7 Btu per sq ft per hr (Fig. 1) or 0.95, 0.98 and 1.02 Btu per sq ft per hr per F, respectively. It is sufficiently accurate to place each of these three values equal to 1. Then, after adding the heat delivered by convection, the total heat delivered by each of these three panels is 1.90, 1.84 and 1.56 Btu per sq ft per hr per F, respectively, for the floor, the wall and the ceiling panel, if it is assumed that the air temperature of the room is practically equal to the mean radiant temperature of the room.

Based on this calculation, it appears safe to adopt the following rule for finding the total heat delivered by a panel: Calculate the heat delivered by radiation and assume that the heat delivered by convection is equal to 80 per cent, 75 per cent, or 50 per cent thereof for floor, wall or ceiling panels, respectively.

Calculating Panel Size

The size of the heating panel for a room may be determined as follows:

1) Calculate the heat requirement of the room. (For example, assume 4000 Btu per hr).

2) Calculate or assume the mean radiant temperature (MRT) of the room (say 70 F).

3) Assume the maximum temperature of the panel (say 105 F for a ceiling panel, 90 F for a wall panel or 80 F for a floor panel).

4) Find from Fig. 1 the heat delivered by radiation for the three panels to be 36, 20 and 10 Btu per hr per sq ft, respectively.

5) Add to these values the respective percentages for heat delivered by convection and find the total heat delivered by the respective panels to be 54, 35 or 18 Btu per sq ft per hr.

6) Divide the total heat requirement of the room, 4000 Btu per hr, by the unit heat delivery of the panels and find the sizes of the panels to be 74 sq ft for the ceiling panel, 114 sq ft for the wall panel or 222 sq ft for the floor panel.

7) If the assumed panel temperatures differ from those suggested above in (3), make corresponding changes in the calculations.

Figuring Pipe Coil Size

Having found the required size of the panel and knowing the total quantity of heat required by the room, the required size of the pipe coil can be calculated if it is known how much heat will be transmitted from the pipe coil to the slab per foot of pipe and for the existing conditions. The pipe coils are generally constructed of ½, ¾ or 1 in. pipe.

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*President, American Society of Heating and Ventilating Engineers. Professor Emeritus, Heating, Ventilating and Air Conditioning, Agricultural and Mechanical College of Texas.

It was shown in July, p. 423, that the heat conveyed from a ½ in. pipe coil in a concrete slab was at the rate of 10 Btu per hr per sq ft of external pipe coil surface per F temperature difference between the water in the pipe and the air beneath the slab. This value is too high to be used in design because the edges of the slab in the experimental set-up were not insulated, because a large portion of the total heat was, no doubt, absorbed by the bed of sand and gravel on the slab and because the radiant temperature of the concrete floor directly under the slab may have been considerably lower than the air temperature.

It has been found by experience that it is safe, under usual conditions, to base a heating panel design on a heat transmission value of about 3.5 Btu per hr per sq ft of external pipe surface and per F temperature difference water to air. This is roughly equivalent to 1.2 Btu per lineal foot of 1 in. standard weight pipe, 1 Btu per ft of ¾ in. pipe and 0.80 Btu per ft of ½ in. pipe.

It is evident that the unit rate of heat delivery by a pipe coil to its concrete or plaster jacket must vary with the distance between pipe coils and with the difference between the temperature of the pipe coil and that of the air. The unit rate of heat delivery increases as the distance between pipe coils increases and also as the temperature difference (water in pipe and air in room) increases. The unit rate of 3.5 suggested above is an average value.

In constructing pipe coils, it is customary to space 1 in. pipe from 12 to 16 in. on centers; ¾ in. pipe from 9 to 12 in. on centers; and ½ in. pipe from 6 to 8 in. on centers.

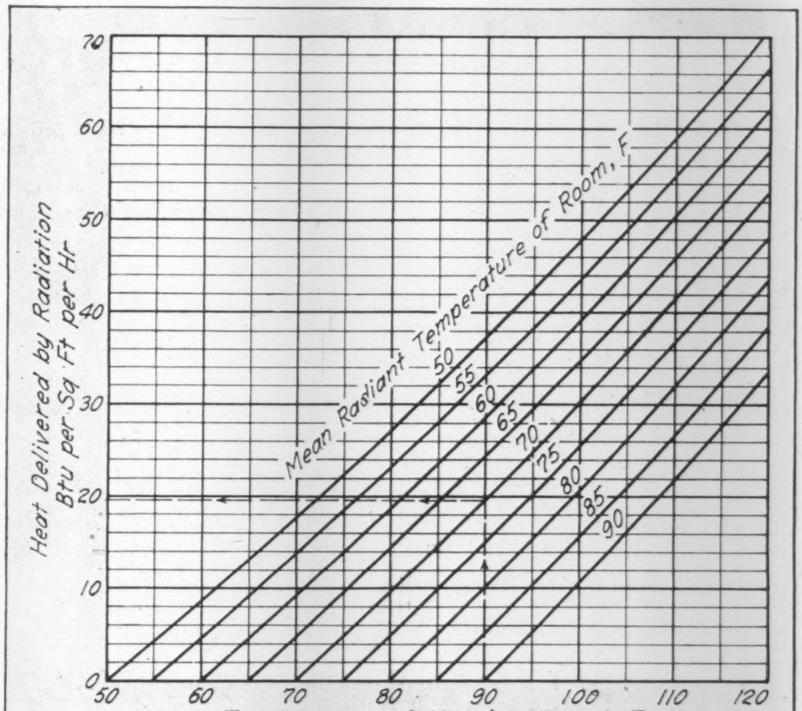

Fig. 1—Heat Delivered by Radiation to Room by Panel

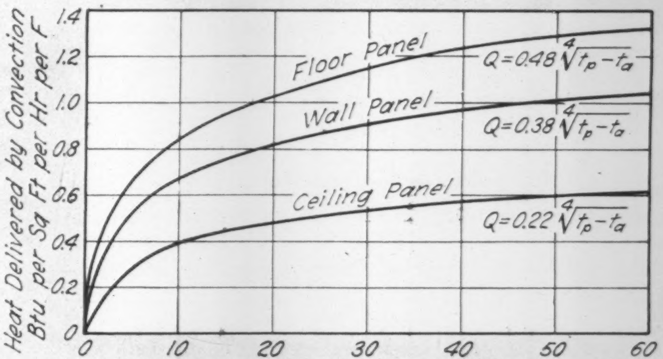

Fig. 2—Heat Transmission from Panel to Air by Convection and Conduction

To design a pipe coil for a ceiling panel having an area of 74 sq ft and delivering 4000 Btu per hr to the room, assume the pipe size and spacing—say ¾ in. pipe spaced 9 in. on centers.

Assume that the insulation of the panel is such that 15 per cent of the heat flows upward and 85 per cent downward; the pipe coil must then deliver 4000/0.85 or about 4700 Btu per hr to the panel. If, say, 90 lineal feet of pipe are used, the heat delivery must be 4700/90 or about 52 Btu per ft. Since 1 ft of ¾ in. pipe delivers about 1 Btu per F temperature difference, water to air, this temperature difference must be 52 deg. Hence, if the air temperature is assumed to be 65 F, the mean water temperature must be 117 F.

If the water flows through the coil at a low velocity so that its temperature drop through the coil is 20 deg, the temperature of the water in the flow riser must be 127 F and in the return riser 107 F. If the velocity is higher, so that the water will cool only 10 deg in flowing through the coil, the temperatures in the flow and return risers must be 122 F and 112 F.

[*Dr. Giesecke's next article on radiant heating will continue with a discussion of the design of a pipe coil for a floor panel. Previous articles by the author on radiant heating and cooling appeared in June and July.*]

Ice Cools Democrats

Cakes of ice in the roof-located air washers of the Chicago Stadium were used to cool the building during the Democratic national convention last month. The ice was hoisted up the outside of the building between the afternoon and evening sessions and after the night session, over 80,000 lb being required for a "filling." Occupancy on nomination night was around 40,000.

The Psychrometric Chart
Its Application and Theory

By William Goodman*

SUMMARY

Publication of the text of this series on the psychrometric chart and its application and theory was completed in the April issue. Since then the appendices have been presented; these show the derivation of the various equations which have appeared in the text sections. The last two of the tables of end points for wet bulb lines for various barometric pressures are also given this month. . . . The series of which this installment is a part has included new psychrometric charts for the low, medium and high temperature ranges, discussion of the theory underlying them, and instructions and supplemental data for solving problems coming up in practice

PUBLICATION of the text of this series on the psychrometric chart was completed in April, and the first eight of the appendices showing how the equations given in the text are derived appeared in May, June and July. Publication of the appendices is concluded this month.

Some of the tables of end points for wet bulb lines for various barometric pressures have already appeared and the last two of them are presented this month. Use of the values given in these tables was explained on p. 613 of the October, 1939, HPAC.

Appendix 9

Derivation of Equation 43 of the Text

Psychrometric Charts A, B and C were constructed by arbitrarily drawing the line of zero degrees dry bulb temperature ($t = 0$) vertical to the horizontal lines of absolute humidity—that is, the angle α of Fig. 36 was made 90 deg for the line of $t = 0$. However, there is no reason why the line of $t = 0$ should be drawn vertical; the line for any other value of dry bulb temperature may be drawn vertical to the horizontal lines of absolute humidity. Not only this, but there is no need for any of the lines of dry bulb temperature to be drawn with $\alpha = 90$ deg; any arbitrarily selected value may be used for the angle α.

However, the value of the ratio s_H/s_M that must be used in constructing the chart is affected by the choice of values for the angles α and β. Hence, it is important to know the relationship between these angles and the ratio s_H/s_M. Such a relationship is derived in this appendix. The derivation given here is valid regardless of whether point *1* of Fig. 36 lies in the unsaturated field of the chart or in the fogged field.

As shown in Appendix 4, the slope of any line of constant dry bulb temperature is

$$q = h_g \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [1]$$

Now a line of constant dry bulb is of physical significance only in the unsaturated field of the chart. It has, of course, no significance in the fogged field of the chart. However, regardless of the fact that a line of constant dry bulb temperature has no physical significance in the fogged field, there is no reason why such a line cannot be extended into the fogged field and used for purposes of geometric construction. Extending such a straight line into the fogged field will not, of course, change its slope. Hence regardless of the points through which a line of constant dry bulb temperature passes on the chart, its slope will always be defined by equation 1 above.

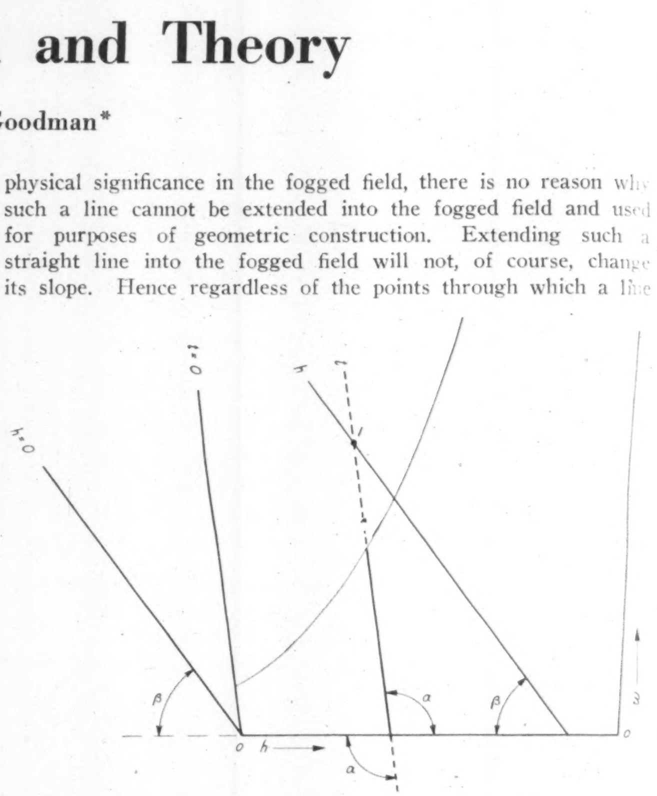

Fig. 36—Skeleton psychrometric chart used for deriving relationship between the scales of the chart and the angles β and α

Now, as shown in Appendix 10, the ratio angle of any line on the psychrometric chart is given by

$$\frac{s_M}{s_H}q = \cot\beta + \cot\theta \quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots [2]$$

For a line of constant dry bulb temperature, the value of q is given by equation 1 and, as is apparent from Fig. 36, the angle α that the line through point *1* makes with the horizontal corre-

Symbols Used

(For complete list, see p. 358, June, 1939, HPAC)

h = enthalpy of air-vapor mixture, Btu per lb of dry air in the mixture

h_g = enthalpy of moisture in vapor state, Btu per lb of vapor

L = actual length of a line on psychrometric chart, in.

q = moisture ratio, Btu per lb of moisture evaporated into the air or condensed from it

s_H = scale to which enthalpy lines are drawn on psychrometric chart, Btu per in. of scale length

s_M = scale to which absolute humidity lines are drawn on psychrometric chart, lb of moisture per in. of scale length

t = dry bulb temperature, deg Fahr

w = absolute humidity of the air-vapor mixture, lb of moisture per lb of dry air in the mixture

θ = moisture ratio angle. See Table 1.

β = slope of enthalpy lines

Subscript "1" refers to the initial state of the substance and subscript "2" refers to its final state.

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*The Trane Co. Member of Board of Consulting and Contributing Editors.

Part 15. Part 1 was published in HEATING, PIPING AND AIR CONDITIONING, June, 1939, pp. 357-360; Part 2 in July, pp. 421-424; Part 3 in August, pp. 485-487; Part 4 in September, pp. 549-551; Part 5 in October, pp. 613-615 and p. 617; Part 6 in November, pp. 671-674; Part 7 in December, pp. 749-752; Part 8 in January, 1940, pp. 6-9; Part 9 in February, pp. 107-110; Part 10 in March, pp. 171-173; Part 11 in April, pp. 239-242; Part 12 in May, pp. 303-305; Part 13 in June, pp. 367-369; and Part 14 in July, pp. 431-433.

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Table 12 - End Points for Wet Bulb Lines
Barometric Pressure 31 in.

Wet Bulb Temp, t'	Dry Bulb Temperature, t				Absolute Humidity, w			
	For w=0		For w= 0.022	For w= 0.11	For t = 40		For t = 120	For t = 450
	Over Ice	Over Water			Over Ice	Over Water		
1	2	3	4	5	6	7	8	9
-20	-18.29	-18.45						
-19	-17.20	-17.37						
-18	-16.11	-16.29						
-17	-15.01	-15.20						
-16	-13.90	-14.10						
-15	-12.79	-13.01						
-14	-11.68	-11.91						
-13	-10.56	-10.80						
-12	-9.43	-9.69						
-11	-8.30	-8.57						
-10	-7.17	-7.45						
-9	-6.02	-6.32						
-8	-4.87	-5.19						
-7	-3.72	-4.05						
-6	-2.56	-2.91						
-5	-1.38	-1.75						
-4	-0.21	-0.59						
-3	+0.98	+0.57						
-2	2.17	1.75						
-1	3.38	2.93						
0	4.59	4.11						
1	5.81	5.30						
2	7.03	6.51						
3	8.27	7.72						
4	9.52	8.94						
5	10.78	10.17						
6	12.05	11.41						
7	13.33	12.66						
8	14.63	13.92						
9	15.94	15.19						
10	17.25	16.47						
11	18.59	17.76						
12	19.93	19.07						
13	21.28	20.38						
14	22.66	21.71						
15	24.05	23.05						
16	25.45	24.41						
17	26.87	25.77						
18	28.31	27.16						
19	29.76	28.55						
20	31.23	29.96						
21	32.72	31.40						
22	34.23	32.84						
23	35.75	34.30						
24	37.30	35.78						
25	38.86	37.27						
26	40.46	38.80			0.00009017			
27	42.07	40.33			0.0004054	0.00007287		
28	43.70	41.88			0.0007250	0.0004163		
29	45.36	43.46			0.001051	0.0007664		
30	47.04	45.05			0.001382	0.001122		
31	48.76	46.68			0.001720	0.001485		
32	50.49	48.32			0.002059	0.001849		
33		49.99				0.002224		
34		51.68				0.002603		
35		53.39				0.002987		
36		55.15				0.003380		
37		56.92				0.003779		
38		58.71				0.004184		
39		60.53				0.004595		
40		62.39				0.005015		
41		64.26						
42		66.18						
43		68.11						
44		70.09						
45		72.11						
46		74.16						
47		76.23						
48		78.35						
49		80.50						
50		82.71						
51		84.95						
52		87.21						
53		89.55						
54		91.90						
55		94.30						
56		96.77						
57		99.26						
58		101.8						
59		104.4						
60		107.0						
61		109.8						
62		112.6						
63		115.4						
64		118.2						
65		121.2					0.0002671	
66		124.2					0.0009215	
67		127.2					0.001609	
68		130.4					0.002305	
69		133.6					0.003021	
70		136.8					0.003748	
71		140.2					0.004496	
72		143.6					0.005264	
73		147.1					0.006052	
74		150.6					0.006852	
75		154.3					0.007672	
76		158.0					0.008511	
77		161.8					0.009383	
78		165.7					0.01026	
79		169.7					0.01116	
80		173.7					0.01209	
81		177.9	81.80				0.01304	
82		182.2	85.98				0.01401	
83		186.6	90.29				0.01502	
84		191.0	94.64				0.01604	
85		195.6	99.10				0.01708	
86		200.3	103.7				0.01817	
87		205.1	108.4				0.01926	
88		209.9	113.2				0.02039	
89		215.0	118.1				0.02156	
90		220.2						
91		225.4						
92		230.8						
93		236.3						
94		242.0						
95		247.9						
96		253.8						
97		259.9						
98		266.1						
99		272.6						
100		279.1						
101		285.9						
102		292.8						
103		299.9						
104		307.1						
105		314.6						
106		322.2						
107		330.2						
108		338.2						
109		346.5						
110		355.0						
111		363.7						
112		372.7						
113		381.9						
114		391.3						
115		401.0						
116		411.0						
117		421.3						
118		431.7						
119		442.4						
120								0.0007443
121								0.003085
122								0.005463
123								0.007956
124								0.01049
125								0.01315
126								0.01585
127								0.01865
128								0.02156
129								0.02453
130								0.02761
131				131.7				0.03077
132				144.7				0.03393
133				158.7				0.03734
134				173.0				0.04086
135				187.0				0.04429
136				202.4				0.04807
137				218.1				0.05196
138				234.1				0.05591
139				250.5				0.05997
140				267.5				0.06420
141				284.9				0.06853
142				303.3				0.07311
143				321.7				0.07771
144				340.7				0.08249
145				360.5				0.08744
146				381.3				0.09266
147				402.7				0.09806
148				424.8				0.1036
149				447.3				0.1093

Table 13 - End Points for Wet Bulb Lines
Barometric Pressure 32 in.

Wet Bulb Temp, t'	Dry Bulb Temperature, t				Absolute Humidity, w			
	For w=0		For w= 0.022	For w= 0.11	For t = 40		For t = 120	For t = 450
	Over Ice	Over Water			Over Ice	Over Water		
1	2	3	4	5	6	7	8	9
-20	-18.35	-18.50						
-19	-17.26	-17.42						
-18	-16.17	-16.34						
-17	-15.07	-15.26						
-16	-13.97	-14.16						
-15	-12.86	-13.07						
-14	-11.75	-11.97						
-13	-10.64	-10.87						
-12	-9.51	-9.76						
-11	-8.39	-8.65						
-10	-7.25	-7.53						
-9	-6.12	-6.41						
-8	-4.97	-5.27						
-7	-3.82	-4.14						
-6	-2.66	-3.00						
-5	-1.50	-1.85						
-4	-0.33	-0.70						
-3	+0.85	+0.46						
-2	2.04	1.63						
-1	3.24	2.80						
0	4.44	3.98						
1	5.65	5.17						
2	6.88	6.37						
3	8.11	7.57						
4	9.35	8.79						
5	10.61	10.01						
6	11.86	11.24						
7	13.14	12.48						
8	14.42	13.73						
9	15.72	14.99						
10	17.02	16.26						
11	18.35	17.55						
12	19.68	18.84						
13	21.02	20.14						
14	22.39	21.47						
15	23.77	22.80						
16	25.15	24.14						
17	26.56	25.50						
18	27.99	26.87						
19	29.42	28.26						
20	30.88	29.66						
21	32.36	31.08						
22	33.85	32.50						
23	35.35	33.94						
24	36.89	35.41						
25	38.42	36.89						
26	40.01	38.40			0.000002611			
27	41.60	39.91			0.0003128			
28	43.21	41.44			0.0006284	0.0003198		
29	44.85	43.00			0.0009503	0.0006659		
30	46.51	44.58			0.001277	0.001017		
31	48.21	46.19			0.001611	0.001376		
32	49.90	47.80			0.001944	0.001734		
33		49.46				0.002104		
34		51.13				0.002479		
35		52.82				0.002858		
36		54.54				0.003245		
37		56.29				0.003638		
38		58.06				0.004038		
39		59.85				0.004443		
40		61.68				0.004857		
41		63.53						
42		65.41						
43		67.32						
44		69.26						
45		71.26						
46		73.27						
47		75.31						
48		77.39						
49		79.51						
50		81.68						
51		83.88						
52		86.10						
53		88.40						
54		90.70						
55		93.06						
56		95.48						
57		97.92						
58		100.4						
59		103.0						
60		105.6						
61		108.2						
62		110.9						
63		113.7						
64		116.5						
65		119.4						
66		122.3					0.0005117	
67		125.3					0.001178	
68		128.4					0.001865	
69		131.5					0.002562	
70		134.7					0.003268	
71		137.9					0.003997	
72		141.3					0.004754	
73		144.7					0.005513	
74		148.2					0.006303	
75		151.7					0.007102	
76		155.3					0.007922	
77		159.1					0.008764	
78		162.9					0.009625	
79		166.7					0.01051	
80		170.7					0.01141	
81		174.8					0.01234	
82		178.9	82.88				0.01329	
83		183.2	87.06				0.01426	
84		187.5	91.29				0.01525	
85		192.0	95.67				0.01627	
86		196.5	100.1				0.01732	
87		201.2	104.7				0.01840	
88		206.0	109.4				0.01950	
89		210.9	114.2				0.02062	
90		215.9	119.1				0.02178	
91		221.0						
92		226.3						
93		231.7						
94		237.2						
95		242.8						
96		248.6						
97		254.4						
98		260.6						
99		266.8						
100		273.1						
101		279.7						
102		286.4						
103		293.3						
104		300.3						
105		307.6						
106		315.0						
107		322.6						
108		330.4						
109		338.4						
110		346.7						
111		355.1						
112		363.7						
113		372.6						
114		381.8						
115		391.2						
116		400.8						
117		410.7						
118		420.8						
119		431.2						
120		441.9						
121								0.0006128
122								0.002902
123								0.005298
124								0.007748
125								0.01029
126								0.01290
127								0.01560
128								0.01835
129								0.02121
130								0.02419
131								0.02726
132								0.03033
133				143.6				0.03358
134				157.2				0.03691
135				171.2				0.04035
136				185.5				0.04386
137				200.5				0.04756
138				215.9				0.05135
139				231.5				0.05523
140				247.9				0.05928
141				264.6				0.06342
142				282.0				0.06776
143				299.7				0.07216
144				318.0				0.07676
145				336.8				0.08146
146				356.8				0.08650
147				377.3				0.09163
148				398.0				0.09686
149				419.8				0.1023
150				442.2				0.1080

sponds to the ratio angle θ of Fig. 3. Hence, making these substitutions into [2],

$$\frac{s_M}{s_H} h_g = \cot\beta + \cot\alpha \qquad [3]$$

But

$$h_g = 0.45t + 1061 \qquad [4]$$

Substituting [4] into [3],

$$\frac{s_M}{s_H} (0.45t + 1061) = \cot\beta + \cot\alpha \qquad [5]$$

Equation 5 gives the relationship between the ratio s_M/s_H and the angles β and α. In equation 5, t is the value of the *one* line of constant dry bulb temperature that is arbitrarily selected to incline at an angle α with the horizontal. No other line of constant dry bulb temperature will be inclined at this angle because the lines of constant dry bulb temperature are not parallel to each other.

The charts of this article were drawn with $\alpha = 90$ deg for the line $t = 0$ deg. For this condition, equation 5 reduces to

$$1061 \frac{s_M}{s_H} = \cot\beta \qquad [6]$$

or

$$\tan\beta = \frac{s_H/s_M}{1061} \qquad [7]$$

Values of s_M and s_H are determined by the range of values to be included on the chart and the desired proportions of the chart. Once the values of s_M and s_H have been found, the value of β, the slope of the enthalpy lines, can be found by means of either equation 5 or 7.

Because the line of $t = 0$ was selected to be drawn vertical in these charts, the line of $t = 120$ deg of Chart A slopes toward the right. It would have been just as easy to draw the line of $t = 120$ vertical — that is, for $t = 120$, $\alpha = 90$. In this case, the line of $t = 0$ would have sloped toward the left of the chart. For finding $\cot\beta$ in this case, equation 5 should be used.

Appendix 10

Derivations of Equations 44 and 45 of the Text

Referring to Fig. 37, according to the Sine Law,

$$\frac{b}{\sin\beta} = \frac{L_H}{\sin\psi} \qquad [1]$$

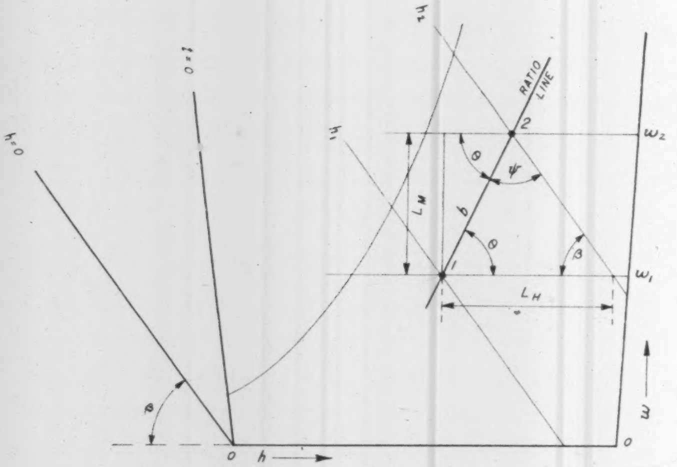


Fig. 37—Skeleton psychrometric chart used for deriving relationship between the ratio angle θ, the moisture ratio q, and the angle β

But,

$$\psi = 180 - (\theta + \beta) \qquad [2]$$

$$\sin\psi = \sin(\theta + \beta) \qquad [3]$$

Also,

$$b = \frac{L_M}{\sin\theta} \qquad [4]$$

Substituting [3] and [4] into [1],

$$\frac{L_M}{\sin\theta \sin\beta} = \frac{L_H}{\sin(\theta + \beta)} \qquad [5]$$

$$\frac{L_H}{L_M} = \frac{\sin(\theta + \beta)}{\sin\theta \sin\beta} \qquad [6]$$

$$= \frac{\sin\theta\cos\beta + \cos\theta\sin\beta}{\sin\theta\sin\beta} \qquad [7]$$

$$= \cot\beta + \cot\theta \qquad [8]$$

But,

$$L_H = \frac{h_2 - h_1}{s_H} \qquad [9]$$

and

$$L_M = \frac{w_2 - w_1}{s_M} \qquad [10]$$

Substituting [9] and [10] into [8],

$$\frac{s_M}{s_H} \frac{h_2 - h_1}{w_2 - w_1} = \cot\beta + \cot\theta \qquad [11]$$

But,

$$\frac{h_2 - h_1}{w_2 - w_1} = q \qquad [12]$$

Therefore,

$$\frac{s_M}{s_H} q = \cot\beta + \cot\theta \qquad [13]$$

and

$$\cot\theta = \frac{s_M}{s_H} q - \cot\beta \qquad [14]$$

This is the basic equation giving the relationship between the ratio angle θ, the angle β, and the ratio s_M/s_H for which the chart is drawn. The ratio s_M/s_H can be eliminated between equation 14 above and equation 3 of Appendix 9, yielding

$$\cot\theta = \cot\beta \left[\frac{q}{h_g} - 1\right] + \frac{q}{h_g} \cot\alpha \qquad [15]$$

Equation 15 gives the basic relationship between the angles θ, β and α. In this equation, h_g is the enthalpy of water vapor at a temperature that is equal to the one dry bulb temperature whose line on the psychrometric chart inclines at an angle α with the horizontal.

For the condition that $\alpha = 90$ deg for the line of $t = 0$ deg, $\cot\alpha = 0$ and $h_g = 1061$.

Substituting these values into [15],

$$\cot\theta = \cot\beta \left[\frac{q}{1061} - 1\right] \qquad [16]$$

$$\tan\theta = \frac{1061 \tan\beta}{q - 1061} \qquad [17]$$

[*Concluded*]

The Use of the Ring Joint on Oil and Steam Piping Service

Temperature and Quench Tests on Ring Joints Are Reported by F. R. Venton[*] and A. W. Marburg[†]

SUMMARY

The ring joint—widely used as a fluid pressure seal for flanged joint connections—comprises a ring of either oval or octagonal cross-section confined within tapered, straight sided grooves cut into the faces of the two flanges. As applied specifically to piping, it was conceived some 15 years ago in the Texas oil fields and has achieved a position as a joint of accepted merit where service conditions—on steam or oil piping—are severe. . . . . The authors gave a mechanical analysis of the ring joint, discussed the effect of flange separation, and explained the advantages of the octagonal ring cross-section in the July HPAC. They pointed out that some trouble has been experienced in various steam power piping systems where oval rings were being used on high pressure service at elevated temperatures, and explained why the same trouble has not occurred in the oil industry. . . . . Realizing the existence of major differences between power plant and oil refinery operations, and the fact that fluctuating line temperature conditions were the greatest single cause for flanged joint leakage, an investigation of the characteristics of the ring joint, with special emphasis on its ability to withstand such fluctuations, was undertaken. Detailed discussion of the results of this investigation is given here, and will be concluded in a third article. . . . . Among the conclusions drawn by the authors as a result of the work are: (1) Joints assembled with rings of octagonal cross-section exhibited better pressure retaining abilities under conditions of fluctuating temperatures than did the joint assembled with a ring of oval cross-section, or any of the joints of the large tongue and groove design tested. . . . . (2) Substantial temperature differentials exist between the component parts of any flanged joint when the temperature of the fluid being transmitted is changed. The thin sections of metal close to the axis of the joint change temperature more rapidly than the heavier flange section, causing flange rotation which may cause leakage

REALIZING the existence of major differences between steam power plant and oil refinery operations (as outlined on p. 427 of the July HPAC), and realizing also that fluctuating line temperature conditions were the greatest single cause for flanged joint leakage, an investigation of the characteristics of the ring joint has been undertaken. The investigation places special emphasis upon the ability of the ring joint to withstand temperature fluctuations.

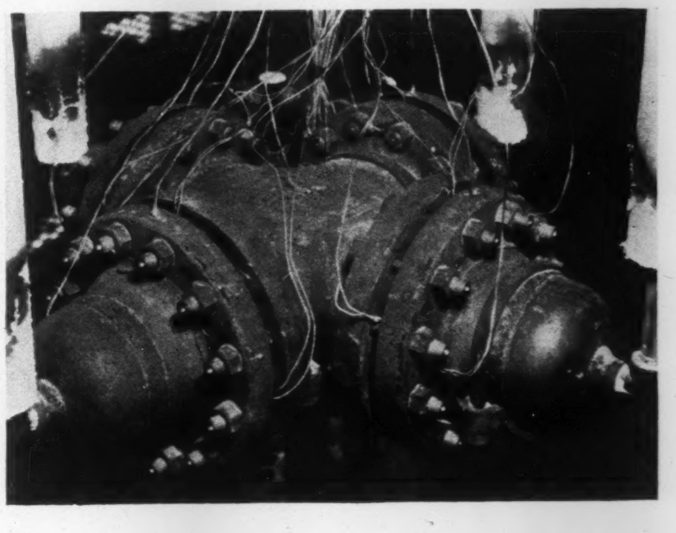
Assembly for Temperature Tests

The first test set-up consisted of a 6 in., 300 lb cross as shown in Fig. 1. The size and pressure rating of the material tested was determined by the quantity of the steam available. In the absence of suitable quantities of steam at higher pressures, 350 lb steam superheated to 1000 F was used. In the center of the bottom surface of the cross was a 1½ in. pipe tapping which served as the inlet. The steam temperature at the inlet was between 835 and 850 F. Each test joint was made up using a welding neck flange with an extra strong cap welded to it. Welded over a drilled hole in the crown of each cap was a ¾ in. half coupling to which the outlet piping was connected. As the cross was mounted in the horizontal position during all tests with the steam entering through the inlet in the center of the cross and leaving by all four outlets, uniform conditions for each test joint were assured.

The flanges and bolting conformed to the 6 in., 300 lb standard, $1\frac{7}{16}$ in. flange thickness and twelve ¾ in. bolt studs. As can be seen from Fig. 2, two oval rings, one octagonal ring, and a large tongue and groove joint were used for the first series of tests. The rings were made of Armco iron, maximum Brinell hardness of 90, in accordance with the ASA Standards, B-16e-1939. The ring cross-sections are shown in Fig. 3. The flat gasket was made of $\frac{1}{32}$ in. Armco iron, uncorrugated. The ¾ in. by 6 in. full threaded bolt studs were made of Templex steel, a chromium-molybdenum-vanadium alloy. A ⅜ in. stainless steel ball was placed in one end of each stud and the other end was centered and chromium plated to prevent oxidation and to facilitate accurate strain determinations. The nuts were made of carbon steel, oil quenched.

As the suggestion had been made that benefits might be derived by reducing the circulation of the fluid in the space immediately adjacent to the ring, one of the welding neck flanges with a ring joint facing had a sleeve welded to it. (Fig. 2—Joint *A*).

Fig. 1—Six in., 300 lb cross assembled for test



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[*] Technical Engineer, Research and Development Dept., Crane Co.
[†] Testing Engineer, Research and Development Dept., Crane Co.

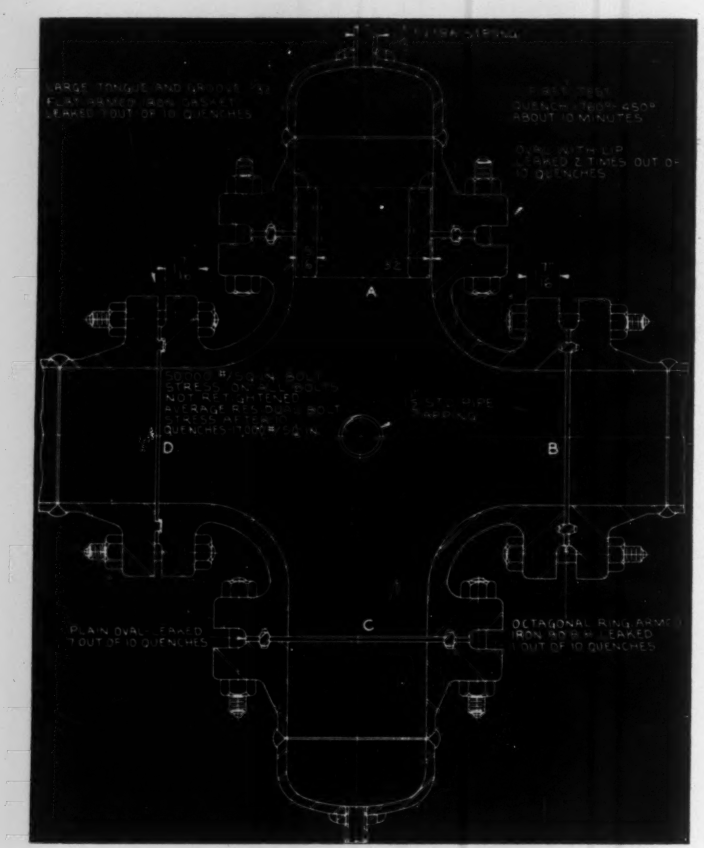

LARGE TONGUE AND GROOVE $\frac{1}{32}$
FLAT ARMCO IRON GASKET
LEAKED 1 OUT OF 10 QUENCHES
FIRST TEST
QUENCH 760°–450°
ABOUT 10 MINUTES
OVAL WITH LIP
LEAKED 2 TIMES OUT OF
10 QUENCHES
A
50000 #/SQ IN BOLT
STRESS ON ALL BOLTS
NOT RETIGHTENED
AVERAGE RESIDUAL BOLT
STRESS AFTER 10
QUENCHES-17,000 #/SQ IN
$\frac{1}{2}$ STD PIPE
TAPPING
D
B
C
PLAIN OVAL-LEAKED
7 OUT OF 10 QUENCHES
OCTAGONAL RING ARMCO
IRON 90 B.H. LEAKED
1 OUT OF 10 QUENCHES

Fig. 2—Six in., 300 lb cast steel flanged cross for test of joints under conditions of fluctuating temperatures, first series of tests

In assembling the joints a light machine oil was used on the rings and the flat gasket. The bolt studs were uniformly tightened, by means of increasing torques being applied to diametrically opposite bolt studs. The elongation of the bolts was checked after each torque application with the instrument shown in Fig. 4. The process was continued until the elongation of the bolts indicated a bolt stress of 50,000 lb per sq in.

$$\frac{L\,S}{E} = e$$

where L = effective bolt length, center of nut to center of nut, in.;

S = bolt stress, lb per sq in.;

E = modulus of elasticity, taken as 30,000,000 lb per sq in.;

e = elongation of bolt, in.

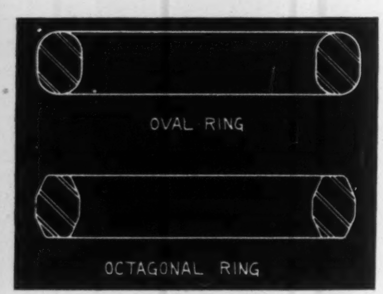
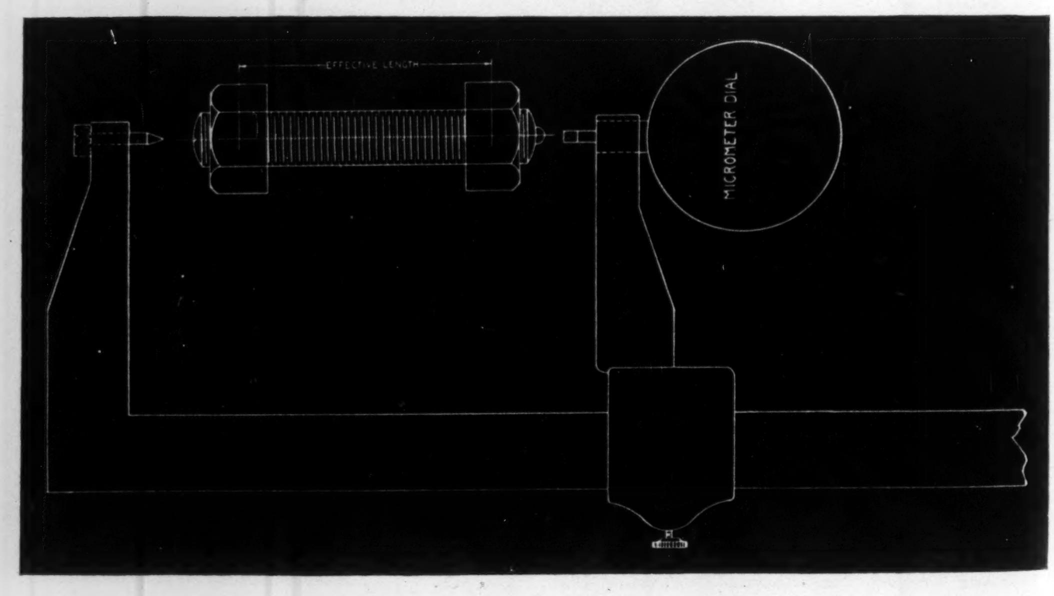

OVAL RING
OCTAGONAL RING

Fig. 3—Top, oval ring. Bottom, octagonal ring

Fig. 4—Instrument for measuring bolt elongation


EFFECTIVE LENGTH
MICROMETER DIAL

Thus, for an effective bolt length of 3½ in. and a bolt stress of 50,000 lb per sq in., the elongation should be:

$$\frac{3.5 \times 50{,}000}{30{,}000{,}000} = 0.0058 \text{ in.}$$

After the assembly had been mounted in the horizontal position, thermocouples were silver brazed to the top of each ring (Fig. 1). The top of each welding neck flange had a small hole drilled on the bolt circle to a depth of one-half the thickness of the flange, in which was placed a thermocouple. Three of the four flanges were similarly drilled on the bottom. The fourth flange, which was used to make up the joint with the ring of octagonal cross-section (Fig. 2, Joint *B*) had a thermocouple at a point 90 deg to the top couple, also placed on the bolt circle. The thermocouples on the bolts were at approximately 90 deg to the flange thermocouples. These couples were silver brazed to the studs on the exposed threaded portion between the flanges.

The assembly was insulated with rock wool. This was achieved by the use of a sheet metal box, Fig. 5, which could be lowered at any time on short notice for the purpose of examining the joints.

First Series of Quench Tests

The joints were warmed over a period of 3¾ hr from room temperature to 760 F. During the warm-up there was at no time a temperature differential greater than 50 deg between the bolts and flanges. The rate of warm-up was limited by the quantity of superheated steam available. The maximum differential between the bolts and the rings amounted to 100 F.

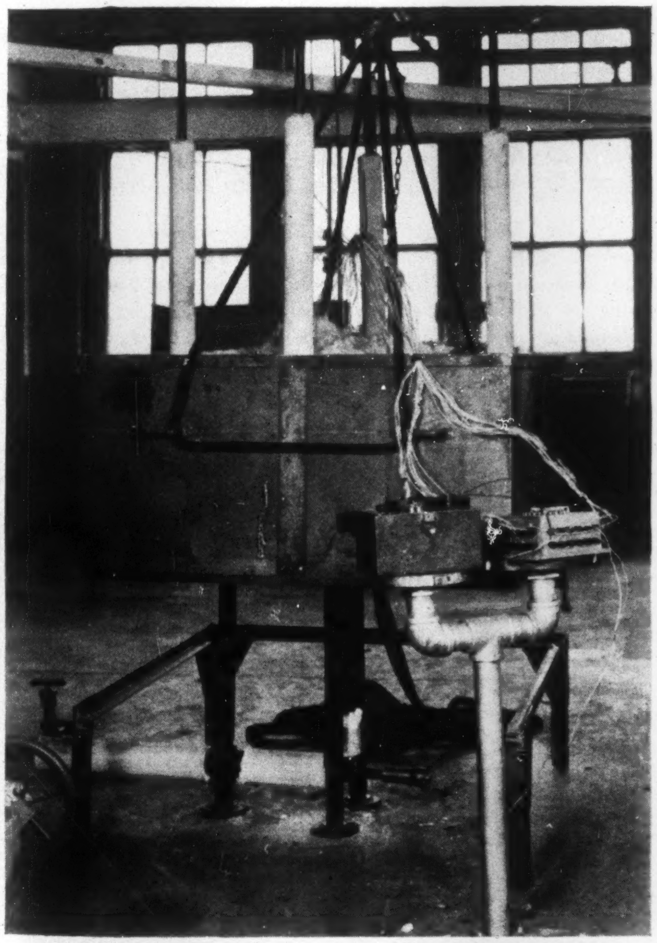
After the assembly had been warmed to a temperature of 760 to 775 F, in which range there was less than a 20 deg difference between any two thermocouples, the superheated steam was shut off, and the joints were subjected to a quench. A quench consisted of introducing 350 lb saturated steam into the cross preceded by 2 gal of accumulated condensate. A temperature reduction of 300 F was effected in 15 min. As the introduction of the quench to the test set-up was undertaken with the idea of determining the temperature differentials which would result from such drastic treatment, a glance at

Figs. 6, 7 and 8 is in order. It is important to note, before analyzing the differentials, that the relative elevations of the thermocouples had a distinct bearing on the reported temperatures; thus, two couples situated equidistant from the periphery of the flange, on the vertical center line, one on top and one on the bottom, exhibit two distinct values, the temperature at the top couple declining less rapidly during a quench than the temperature at the bottom couple. Fig. 6 shows a maximum temperature differential of 140 F between the bolts and the bottom of the flange of the joint made up with the oval ring, no sleeve (Fig. 2, Joint *C*). The comparable differential for Joint *A* with the sleeve was only 100 F (Fig. 7), indicating a reduction in flange to bolt temperature differentials caused by the sleeve. The sleeve also caused a reduction of differentials between the flanges and the ring; the maximum temperature difference between the ring and the top flange couple was 45 F. The benefits accruing from the use of the sleeve, as evidenced by reduced temperature differentials, could have been a result of reduced fluid circulation between the flanges and adjacent to the ring or a result of the thermal inertia of the sleeve, which was $1\frac{5}{16}$ in. thick.

Second Series of Quench Tests

To eliminate the variable of thermal inertia the sleeve thickness on the second series of tests was reduced to $\frac{3}{16}$ in. As shown in Fig. 9, all four test joints on the second assembly were equipped with light weight sleeves.

Fig. 5—Method of insulating test assembly



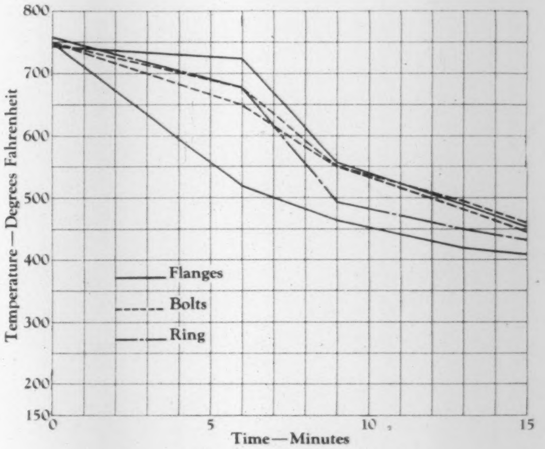


Fig. 6—Oval ring joint, first series, uninsulated, fifth quench

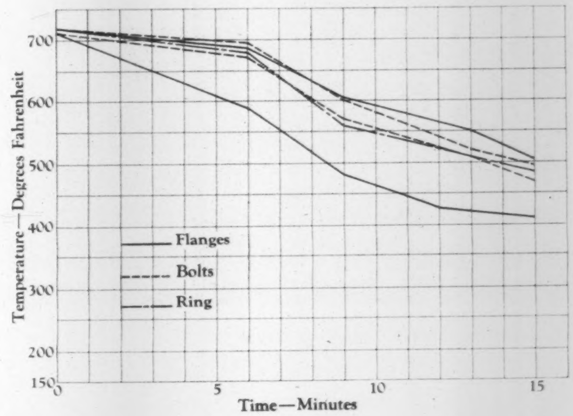


Fig. 7—Oval ring joint with lip, first series, uninsulated, fifth quench

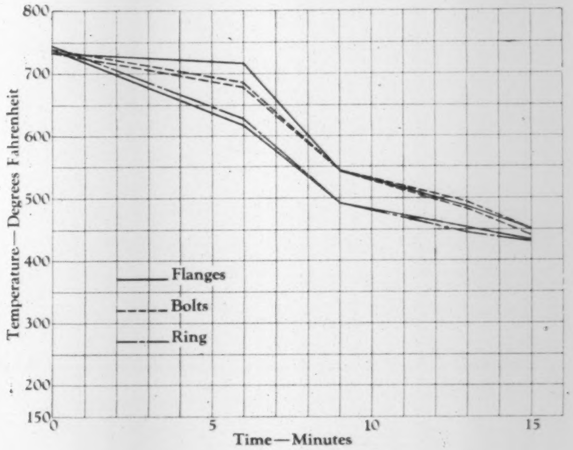


Fig. 8—Octagonal ring joint, first series, uninsulated, fifth quench

The average bolt load loss during the first series of 10 quenches over a period of three weeks amounted to 67 per cent. For this reason, a further modification in the second series of quenches was the use of different bolt stresses. Two of the joints on the second series were assembled with bolt stresses of 70,000 lb per sq in., one a flat gasket and the other a ring joint with ring of octagonal cross-section. The other two joints were assembled with bolt stresses of 50,000 lb. These two stresses were employed to determine the relative

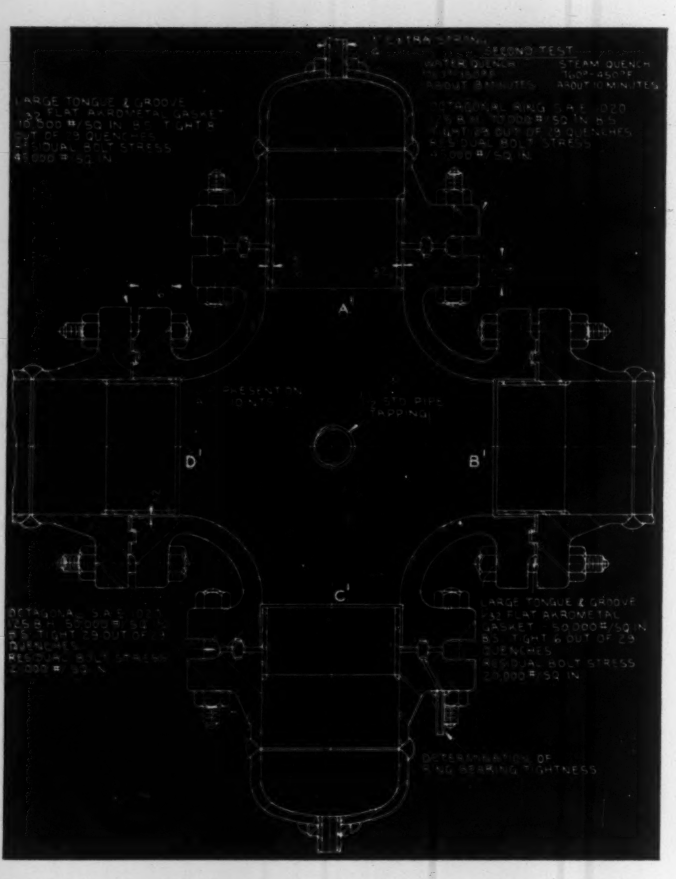

SECOND TEST
WATER QUENCH
ABOUT 8 MINUTES
STEAM QUENCH
160°-450°F
ABOUT 10 MINUTES
LARGE TONGUE & GROOVE
32 FLAT AKROMETAL GASKET
10,000 #/SQ IN. B.S. TIGHT 8
OUT OF 29 QUENCHES
RESIDUAL BOLT STRESS
45,000 #/SQ IN.
OCTAGONAL RING S.A.E. 1020
125 B.H. 70,000 #/SQ IN. B.S.
TIGHT 29 OUT OF 29 QUENCHES
RESIDUAL BOLT STRESS
47,000 #/SQ IN.
A'
B'
C'
D'
STD PIPE
TAPPING
OCTAGONAL S.A.E. 1020
125 B.H. 50,000 #/SQ IN.
B.S. TIGHT 29 OUT OF 29
QUENCHES
RESIDUAL BOLT STRESS
LARGE TONGUE & GROOVE
32 FLAT AKROMETAL
GASKET 50,000 #/SQ IN.
B.S. TIGHT 6 OUT OF 29
QUENCHES
RESIDUAL BOLT STRESS
20,000 #/SQ IN.
DETERMINATION OF
RING BEARING TIGHTNESS

Fig. 9—Six in., 300 lb cast steel flanged cross for tests of joints under conditions of fluctuating temperatures, second test series

rapidity of bolt load loss with initial bolt stresses of 70,000 and 50,000 lb per sq in.

As the temperature information from the first series of tests showed that the ring contracted faster than the flanges under quenching conditions, it was decided to drill a small hole into the groove of the welding neck flange used on Joint *C′*, Fig. 9, to determine whether the rapid contraction of the ring was enough to make it pull away from its outside bearing. Maintaining 90 lb per sq in. air pressure in the groove by balancing an air supply with a vent made it possible to tell when the outside or inside seal was broken or resealed.

A recording pressure gage was connected to the system to make it unnecessary to watch the gage. If and when the outside seal was broken the system was thrown out of balance and the pressure fell until such a time as the seal was restored, at which instant the pressure in the system began to rise again. If the inside seal broke, a pressure of 350 lb per sq in. was admitted to the system and the pressure rise was likewise recorded on the chart.

Use of Water for Quenching

The first tests conducted with the second set-up indicated the correctness of the idea that the outside bearing of the ring would break its seal during a quench. The apparatus worked perfectly; it showed that the pressure in the groove declined during the period of severest temperature differentials and that gradually the pressure built up again as more uniform temperatures were reestablished. It was reasoned then, that the ring joint did not leak steam during a steam quench because the ring contracted more rapidly than the groove and assured a tight seal on the inside bearing. Following this line of reasoning, it seemed logical to expect that the magnitude of the leakage which had been experienced with both flat gasket joints during the steam quenches could be increased by performing a more severe quench, by introducing room temperature water at 350 lb per sq in. pressure to the test apparatus.

Eleven steam quenches preceded the first water quench. Both flat gasket joints leaked on the last eight steam quenches. The procedure for the water quench was the same as it had been for steam; the test joints were warmed to 760 F, the superheated steam was shut off and the water introduced. Contrary to expectations, all the joints were tight. On two successive water quenches they were still tight. The next quench (15th) was a water and steam quench. After the water had been allowed to run through the assembly for about 2½ min, it was turned off and saturated steam introduced. Once again the flat gasket joint (Joint *B′*, Fig. 9), assembled with 50,000 lb per sq in. bolt stress, leaked.

[In the July HPAC, the authors presented a mechanical analysis of the ring joint, discussed the effect of flange separation, pointed out the advantages of the octagonal ring and analyzed the differences between oil refinery and steam power plant piping service conditions. In a third article, the following subjects will be considered: hub contraction of welding neck flange, blind flanges and bolt load losses.]

HOUSING FOR WAR INDUSTRY WORKERS

Adequate housing for workers in war industries, a vital item in the nation's general defense program, is being made the subject of a special survey by The Twentieth Century Fund, according to an announcement by Evans Clark, executive director.

"The country must know what will be the housing needs of the many thousands of workers who will be drawn into our industrial defense program," said Mr. Clark. "We want to review what was done on this problem in the first world war—to see what measures were successful and what mistakes were made. We want to estimate what the probable current needs will be and how best to meet them."

In discussing the origin of the survey, Mr. Clark said, "The present emergency survey represents an enlargement of a general survey of housing that has been in progress for more than a year. The Fund is undertaking this emergency research on its own responsibility, and is bearing all of the costs itself. The Twentieth Century Fund has received assurances, however, that the survey will be of great value to the National Defense Commission and it is happy to assist."

Outlining more specifically some of the objectives of the survey, Miles L. Colean said: "Our main attention will be focused on policy. The time is so short and the necessity is so immediate that there won't be opportunity for a large statistical study. We plan to analyze housing policy in relation to industrial policy. One guiding principle is to try to find ways of meeting present needs that will cause a minimum amount of future readjustment when normal conditions are restored."

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

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Cooler Footcandles for Air Conditioning

By W. G. Darley[*], Cleveland, Ohio

ABSTRACT

The need for better lighting, emphasized by the new researches on seeing, is being met with numerous installations providing values of general lighting that would not even have been considered a few short years ago. At the same time one of the hindrances to having these needed footcandles is the complex psycho-physiological reaction which causes us to brand an installation as *too hot*.

There seem to be three principal reasons which cause the feeling that an installation is warm: the total heat liberated in a space, the radiant heat emitted by the light source, and the psychological reaction of the observer to the color and brightness of the source and of the surroundings.

Lighting practice with large tungsten-filament lamps has been taking these three factors into account.

Lighting with Type *F* (fluorescent) lamps opens up new horizons. In the first place the lamps provide about twice the efficiency of Type *C* (gas-filled, tungsten-filament) lamps; in the second place they are being utilized in direct and direct-indirect lighting systems with the result that higher utilizations are obtained. Thus for the same total heat effect, two or more times as much light with Type *F* lamps as with Type *C* lamps, can be obtained.

Because of the method of light generation in a Type *F* lamp the heat effect per footcandle from the 40-w white *F* lamp is only about one-fifth that from large Type *C* lamps. When a thin piece of ordinary glass is interposed between this white fluorescent lamp and the place where the footcandles are measured, the radiant heating effect per footcandle is less than one-half that of daylight through an open window!

In properly-designed direct and direct-indirect fluorescent lighting systems the brightnesses in the normal line of vision can be maintained at a relatively low value and, furthermore, the light is of a *cooler* color; thus the psychological heating effect is reduced.

From the data presented it appears that from the standpoint of ventilating and illuminating engineering the potentialities of the new source are tremendous.

In a fundamental paper[1] presented in 1938, some comment was made on the fluorescent lamp, a new light source then under development which was not commercially available; however, data were presented covering an experimental 15-w (watt) white fluorescent lamp. In the intervening 2½ years the 15-w white Type *F* lamp has not only been made available, but has been improved to a point where its efficiency is 30 per cent higher than the experimental lamp which was described. Furthermore, higher wattage lamps (20, 30, and 40 w) are now listed which have even higher light outputs per watt input. For instance, the 40-w white fluorescent lamp with an efficiency of 53 l/w (lumens per watt)[†] is over 75 per cent more efficient as a light producer than the experimental lamp.

These developments have greatly broadened the field of application for this type of source beyond that suggested in the previous paper. No longer are the fluorescent lamps considered only as better tools than the lumiline lamps for use in auditoriums, theaters, restaurants, etc. They have taken their place with Type *C* (gas-filled tungsten-filament) and Type *H* (mercury) lamps in the lighting engineers' kit as sources of many uses. Already approximately four million are in use.

During the past 2½ years there has also been a considerable amount of new research on seeing as it is influenced by lighting.[2, 3, 4, 5, 6] In addition to the technical reports of these data the continuation of the *better light—better sight* movement and the activity on light-conditioning are bringing the researches to the attention of the public without undue delay. More information is now available on the effect of better lighting on selling in the store[7] and production in the factory.[8] The cumulative effect of all these factors has been to improve lighting practice both as regards quantity of light (footcandles) and quality of lighting (considering glare, distribution, diffusion, shadows, etc.). For instance, in 1938 the recommended minimum standards of illumination for private and general office classifications of *no close work* and *close work* were 10 and 20 ft-c. For some time the accepted minimum standards for such work have been 20 and 30 ft-c respectively. Research previously mentioned indicates that for many common office tasks 100 ft-c or more are really necessary for true seeing ease.[9]

Of course, it has been possible to achieve the higher footcandle values in isolated instances by means of general plus supplementary lighting. Fig. 1 illustrates this method. In this case, 30 ft-c of general illumination from indirect luminaires are supplemented with about 80 ft-c from the directional unit located over the desk. This method, however, is only suitable where the areas or materials to be lighted are permanently fixed in place; and even then the quality of the lighting leaves something to be desired as the brightness of the supplementary source can cause annoying reflections. It is found, therefore, that the solutions for most office lighting problems (solved with Type *C* lamps) have been large-area, low-brightness general lighting systems. One of the most common systems of this type is that using conventional indirect luminaires in conjunction with a matte white ceiling (Fig. 2).

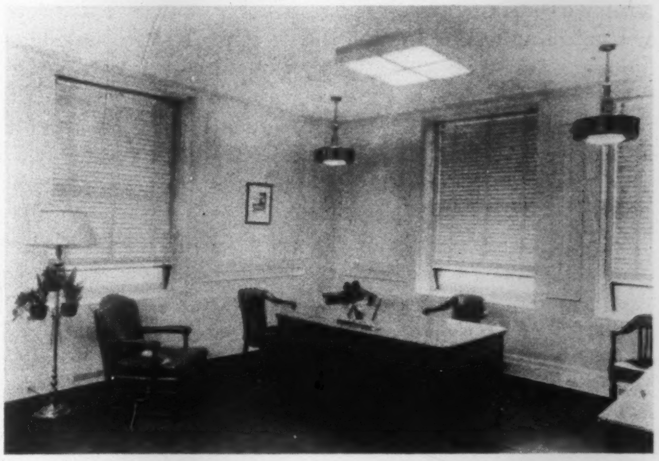

Fig. 1—Private office with location of desk fixed, the directional supplementary lighting unit mounted at ceiling adds 80 ft-c to the 30 ft-c from general lighting units to give over 100 ft-c on the work

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[*] Nela Park Engineering Dept., General Electric Co.

[1] Numbers refer to Bibliography.

[†] Lamp alone, at 100 hours.

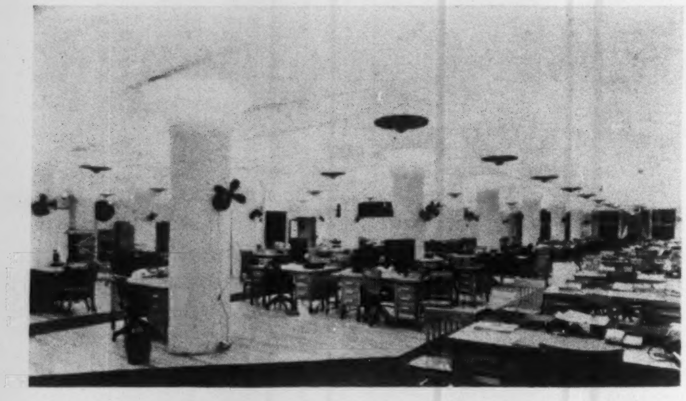

Fig. 2—Typical indirect luminaires utilizing silvered-bowl lamps with flat white ceiling

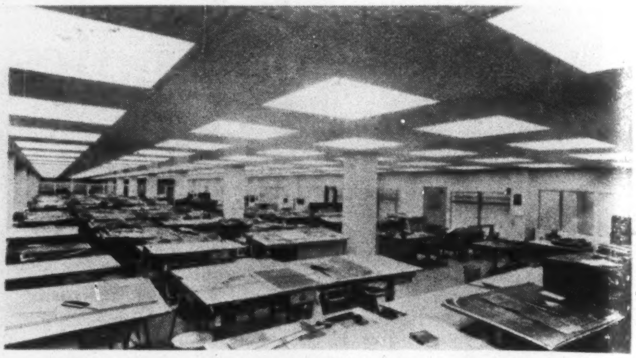

Fig. 3—Coffers 4 ft x 4 ft recessed into ceiling 15 in. to provide higher utilization than obtained from conventional indirect systems

One of the hindrances to the utilization of higher footcandles of general lighting with Type *C* lamps has been the complex psycho-physiological reaction which causes us to brand an installation as *too hot.* Three of the components which influence this reaction are: (1) total heat liberated in a space; (2) radiant heat which, for the purposes of this discussion, may be stated in terms of the amount of radiated energy per unit of light; and (3) psychological reaction to the color and brightness of the source, to the color and brightness of the surroundings, etc.

Good commercial general lighting practice with Type *C* lamps today (20 to 30 ft-c) involves the use of a wattage of the order of 4 to 6-w per square foot. From the data presented in 1938 it is indicated that during a 7-hour period this loading would raise the temperature in a completely unventilated office (17 ft by 17½ ft, two windows) only 3 to 4½ F. Since with the two windows and transom open on a typical summer day the rise would be much less, about 1 F, it appears that artificial ventilation could readily provide comfortable conditions with the above loading from the standpoint of the total heat effect.

At the same time it appears that 20 to 30 ft-c from Type *C* sources should cause little complaint from the standpoint of radiated heat. For instance, an experiment was conducted recently[10] in which subjects were blindfolded and had light directed upon their foreheads. The light was interrupted four times per minute. The average minimum illumination from bare 100-w tungsten-filament lamps which the subject could detect by a barely noticeable increase in the sensation of warmth was 125 ft-c (range 75 to 175 ft-c). It appears quite reasonable to suppose that had the light been directed upon the forehead without interruption for a longer period (30 min or more), the illumination detected might have been lower, because when radiant energy is absorbed by the skin it has the same heating effect on the skin as on any other object except that the skin has one added method of disposing of some of the heat, that of the bloodstream being able to carry it away. Doctors Winslow, Herrington, and Gagge[11] in a series of elaborate experiments determined that the most pleasant condition was registered when the skin temperature is around 90 F. At 5 F above or below this the subject complains of warmth or cold. It is logical to assume, of course, that the amount of variation required to cause complaint would differ for individuals and that some degree of discomfort must be present as soon as the temperature varies from the most pleasant condition even though the point is not reached where the subject is conscious of the discomfort and complains. However, from these tests it does seem obvious that 20 or 30 ft-c should not cause any annoyance because of radiant heat.

The foregoing considerations leave psychology to bear quite a bit of the burden of guilt for producing complaints of heat. The *blindfold test* previously mentioned is fundamental for it suppresses psychological factors. One has often experienced the sensation of heat in interiors lighted with artificial illuminants and therefore may expect artificial lighting to be warm, having burned fingers many times changing lamps. Heat is associated with the *warm* color of light from Type *C* lamps, and naturally the more light the hotter it seems.

Lighting practice has taken these factors into account in recent higher footcandle installations using Type *C* lamps. For instance, reductions in total heat per footcandle have been obtained by developing lighting methods which provide higher utilizations, *e.g.*, more footcandles per watt expended. One of the most popular methods of this type is that known as coffer lighting, illustrated in Fig. 3.[12] This method involves the use of large coffers (some 4 ft x 4 ft, and 15 in. deep) recessed in the ceiling and equipped with louvers to shield the eyes from the brightest portion of the silvered-bowl lamps used. In effect, the coffer is a very large direct lighting unit. Besides having a higher utilization, the coffer method results in the highest ceiling brightness being hidden from normal view, thus reducing the psychological sensation of heat.

The matter of radiant heat has also come in for its share of study. As a result of cooperation between paint manufacturers and illuminating engineers progress has been made on the development of a new type of paint for use on light-reflecting surfaces. Paints have been made which reflect 75 per cent of the light (visible radiation) emitted from Type *C* lamps but which reflect only 30 per cent of the total energy radiated from these lamps.[13]

One of the most interesting approaches toward overcoming the undesirable psychological sensation of heat from too high a brightness in the field of view has been the development of a metal ceiling with an aluminum finished surface having ridges of a special contour which reflect the light rays in such a manner that a larger percentage is directed downward, reflections near the horizontal being minimized[14] (Fig. 4). As a result, the brightness of this ceiling, when viewed from a distance, appears much less than that of the usual flat white ceiling receiving the same light flux. Thus for the same number of footcandles on the work plane the sensation of brightness is materially reduced, the color of the ceiling changes from the warm white obtained with a flat white ceiling to a neutral gray, the result being that the psychological reaction is decidedly on the cool side.

It appears, therefore, that the way is still not closed to the attainment of higher values of *cool* footcandles with Type *C* lamps.

Now take into consideration fluorescent lighting and its effect on air conditioning as regards (1) total heat, (2) radiant heat, and (3) psychological reactions.

Total Heat

The Type *F* lamp differs radically from the Type *C* and Type *H* lamps in that instead of being concentrated and having a high brightness (maximum for 500-w inside-frosted Type *C* lamp—290 candles per square inch) it is extended and has a relatively low brightness (maximum for 40-w white Type *F* lamp—4 candles per square inch). While the source brightness of the fluorescent lamps, when compared to that of the filament lamps, is thus hardly more than a glimmer, it is still high enough to be a limitation to the indiscriminate use of fluorescent lamps for direct and direct-indirect lighting in commercial areas. It is felt, for instance, that the brightness of the 1-in. (T-8) Type *F* lamps is high enough to exclude their use in any system which permits direct viewing of the lamps by or direct specular reflection of the lamps to the eyes of the observer. On the other hand, for the majority of commercial uses the brightness of the 1½-in. (T-12) Type *F* lamp is judged to be tolerable from the standpoint of reflected brightness, particularly if footcandles are high (50 ft-c and up). At the same time, the brightness of the T-12 lamp is higher than one would care to tolerate in the normal line of vision.

There are two viewing directions for which the fluorescent lamps can be shielded: one for viewing crosswise, or normal, to the axis of the lamp (Sketch *A*, Fig. 5); and the other for viewing along the axis of the lamp (Sketch *B*). The maximum brightness is encountered when viewing crosswise. Observation indicates that for viewing in this direction if the T-12 lamp is shielded to a 45 deg angle below the horizontal (Sketch *C*), a good degree of comfort will prevail; that for viewing along the axis, a shielding angle of at least 30 deg is desirable (Sketch *D*). The shielding media can be either opaque or translucent—if the latter, their brightnesses should be of a low order, depending somewhat upon the system. Of course, more shielding than indicated should provide greater freedom from the possibility of annoying direct glare. In other words, if care is taken, the T-12 Type *F* lamp may be used to provide direct and direct-indirect lighting with an acceptable degree of comfort. Figs. 6, 7, and 8 illustrate such typical fluorescent lighting methods. These systems result in higher utilization of the light generated than the more commonly-used, comfortable forms of filament lighting.

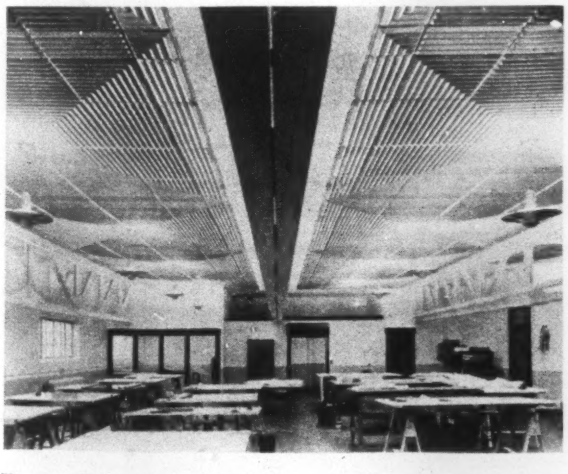

Fig. 4—Formed metal ceiling painted with aluminum paint directing light downward rather than diffusing it in all directions, as in flat white ceiling

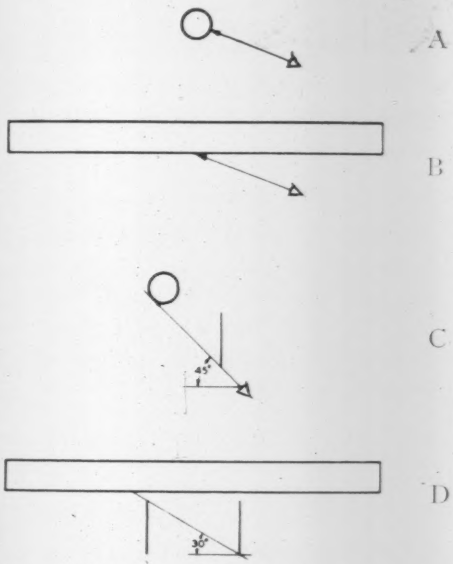

Fig. 5—Maximum fluorescent lamp brightness is found at the normal or crosswise viewing angle, A

Thus there are often two factors which tend to reduce the total heat per footcandle with Type *F* lamps: (1) higher lamp efficiency, and (2) higher utilizations of light. For instance, Table 1 shows the relative watts (and Btu) per square foot required to obtain 50 ft-c average in service in typical large and small offices. Since the auxiliaries for the Type *F* lamps are usually located in the same room with the lamps, the

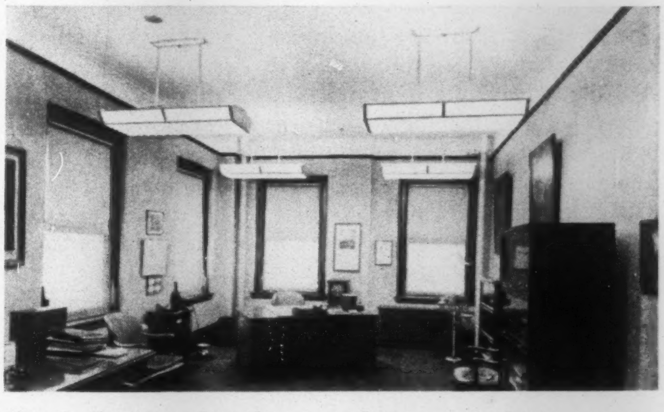

Fig. 6—Six 40-w white fluorescent lamps per outlet in open top direct-indirect luminaires. "Eggcrate" louvers provide shielding of the lamps from below. Forty-five footcandles average in service are obtained in the room

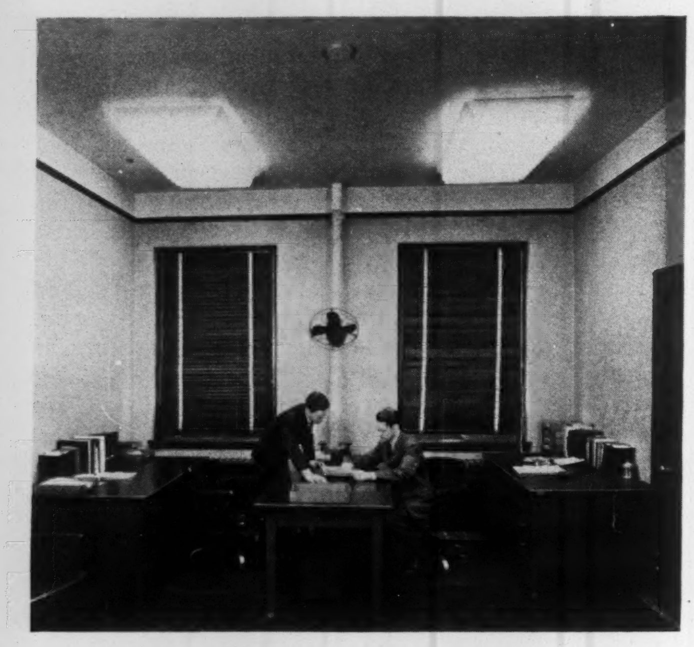

Fig. 7—Direct lighting units mounted at ceiling, each accommodating six 40-w white fluorescent lamps, provide 40 ft-c average in service in office

wattage (heat) losses in the auxiliaries are included. For the indirect and coffer filament systems and the direct-indirect and troffer fluorescent systems, it is apparent that for the same dissipation of total Btu per square foot, it is possible to obtain over twice as many footcandles with fluorescent lighting as with filament lighting. Considering an extreme case, an allowance of 5-w per square foot in an office 14½ ft x 17½ ft (11½-ft ceiling) would work out as follows:

1. Conventional indirect (filament lamps).............16 ft-c
2. Coffer (filament lamps).............................27 ft-c
3. Troffer (fluorescent lamps).........................64 ft-c

Thus, if 5w per square foot is a practical load for which to air condition today, desirably high footcandles are immediately available with Type *F* lamps.

Radiant Heat

While the reduced total heat per footcandle with fluorescent lighting is significant, it is in the lower radiant energy per lumen that the greatest gain lies.

One is not conscious of any great amount of heat or heating effect from the hundreds of footcandles of light coming from the sky through a window or in the shade outdoors. Daylight footcandles are relatively cool, primarily because the high temperature of the sun results in much less invisible energy accompanying each lumen than is the case for most artificial illuminants. This is analogous to a high luminous efficiency for a lamp. In addition to this primary cause of cool daylight footcandles, the water vapor in the atmosphere absorbs a considerable percentage of the invisible infra-red energy accompanying the light. The result is high illumination without perceptible or undue discomfort due to heating effect. Type *F* lamps provide *daylight* footcandles, partly due to the increase in luminous efficiency and partly due to the methods of light-production involved. A study of Figs. 9 and 10, illustrating the energy distributions of a 500-w Type *C* lamp and a 40-w white Type *F* lamp respectively, shows that on the basis of total radiated energy the radiated watts per lumen for the filament lamp are 0.045, for the fluorescent lamp are only 0.0087. Thus 250 ft-c from fluorescent lamps are no warmer than 50 ft-c from filament lamps!

Table 1—Approximate Watts Per Square Foot for 50 Footcandles Average in Service for Various Lighting Systems

System	Room Size[a] Width Ft	In.	Length Ft	In.	Utilization	Watts per Sq Ft[b]	Btu's pe Sq Ft per Hou Lamp Operatio
Filament Lighting							
Conventional Indirect.	14	6	17	6	0.25	15.4	52.5
Conventional Indirect.	50		70		0.44	8.7	29.8
Coffer..............	14	6	17	6	0.36	9.3	31.6
Coffer..............	50		70		0.52	6.4	21.9
Fluorescent Lighting							
Direct-Indirect.......	14	6	17	6	0.31	5.3	18.1
Direct-Indirect.......	50		70		0.46	3.6	12.2
Troffer..............	14	6	17	6	0.39	3.9	13.4
Troffer..............	50		70		0.55	2.8	9.5

[a] All ceiling heights 11 ft 6 in. Average reflection factors: Ceiling 75 per cent; sidewalls 30 per cent.

[b] Includes losses in ballasts of Type *F* lamps—40-w white Type *F* lamps over-all efficiency 43½ lumens per watt. Type *C* lamps at 20 lumens per watt.

Besides confirming that the heating effect per footcandle for light from 40-w white Type *F* lamps is only about one-fifth that of light from large Type *C* lamps, Table 2 reveals other surprising results. For instance, the heating effect of light from the 40-w white Type *F* lamp is only about twice that of the *coolest* daylight *e.g.,* skylight through a closed window. When a thin piece of ordinary glass is interposed between the lamp and the place where the footcandles are measured, the heating effect per footcandle is even less than that of the *coolest* daylight!

To find out whether or not the energy distribution data (Figs. 9 and 10) and the energy-footcandle measurements (Table 2) really applied to human beings, the blindfold test was repeated using a bare 15-w daylight Type *F* lamp (30 lumens per watt). With the light directed upon the forehead interrupted four times per minute the average minimum illumination which the subjects detected by a barely noticeable increase in the sensation of warmth was 600 ft-c (spread 500 to 700 ft-c).

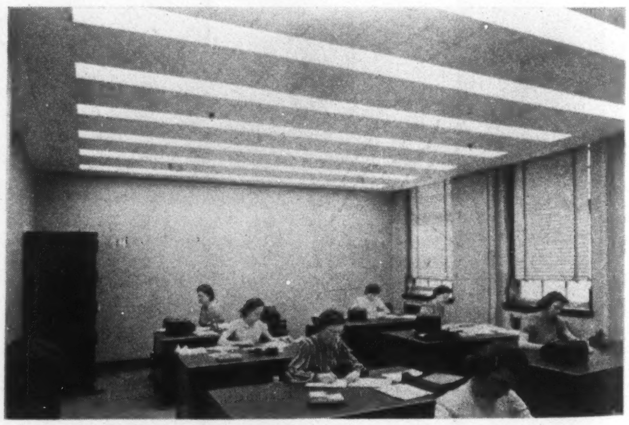

Fig. 8—Troffer system of fluorescent lighting, for use with sound-conditioning. Continuous rows of troffers, on 3-ft centers, accommodating 40-w white fluorescent Type *F* lamps provide an illumination of 45 ft-c

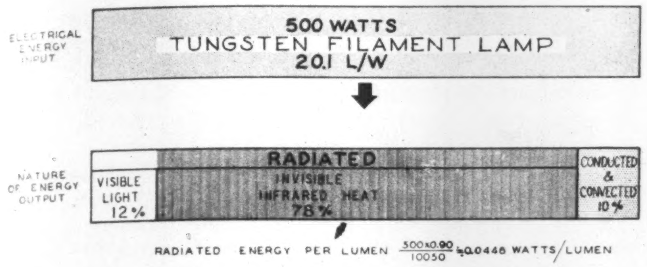
ELECTRICAL ENERGY INPUT
500 WATTS
TUNGSTEN FILAMENT LAMP
20.1 L/W
NATURE OF ENERGY OUTPUT
RADIATED
VISIBLE LIGHT 12%
INVISIBLE INFRARED HEAT 78%
CONDUCTED & CONVECTED 10%
RADIATED ENERGY PER LUMEN $\frac{500 \times 0.90}{10050}$ = 0.0448 WATTS/LUMEN

Fig. 9—Distribution of the energy emitted by a 500-w tungsten-filament lamp[16]

This compares to the average of 125 ft-c previously given for the 100-w Type *C* lamp. Extrapolating, it is found that for the more efficient 500-w Type *C* and 40-w white Type *F* lamps the ratio would be about 160 to 900 ft-c. Thus these more practical tests show that the energy content of the light from the more efficient Type *F* lamps is only of the order of 1/5 to 1/6 that of the light from commonly-used Type *C* lamps. The blindfold test thus verifies with human skin and its sensory nerves the results obtained with the thermopile which measured the heating effect per footcandle. Approaching the coolness of natural daylight with artificial daylight is an achievement of very great significance and potentiality.

Psychological Effect

Psychological reactions are determined in large measure by past experiences one way or another. Thus, to date the sensation of heat from artificial illumination in interiors has often been experienced and, although it is likely to be warm, the heat in footcandles from skylight through windows is not expected to be noticeable. It should also be noted that with daylight we are accustomed to hundreds of footcandles without an undue sensation of heat while artificial lighting has been felt to be warm at relatively low illuminations. Since both the white and daylight Type *F* lamps have color temperatures nearer to that of daylight than commonly-used Type *C* lamps, the light from the Type *F* lamps is definitely psychologically cooler than that from Type *C* lamps. Naturally the daylight Type *F* lamp rates considerably *cooler* on this basis than the white Type *F* lamp.

Within limits, a reduction in the area or degree of a brightness in the field of view results in a reduction in the psychological sensation of heat. In many of the systems utilizing the T-12 Type *F* lamps, the lamps are well shielded from the view of the room occupants but not from view by the work. (Figs. 6, 7, 8). Thus the brightness of the work is increased without increasing the brightness of the luminaires or ceiling in the normal field of view. Naturally, the sensation of heat also depends somewhat upon the color and intensity of all surrounding brightnesses.

Table 2—Approximate Relative Radiant Energy or Heating Effect Per Footcandle

Source	Relative Energy per Footcandle
40-w white Type *F* lamp (53 l/w)	1.00
40-w daylight Type *F* lamp (45 l/w)	1.25
40-w inside-frosted filament lamp (11.7 l/w)	6.6
100-w inside-frosted filament lamp (16.2 l/w)	5.7
200-w inside-frosted filament lamp (18.4 l/w)	5.1
500-w inside-frosted filament lamp (20.0 l/w)	4.5
Sunlight through open window	1.25
Sunlight through ⅛ in. glass window	1.04
Skylight through ⅛ in. glass window	0.67
⅛ in. of ordinary glass interposed between 40-w white Type *F* lamp and surface on which measurements were made[a]	0.44

[a] For filament lamps this would result in about a 20 per cent reduction in heating effect per footcandle.

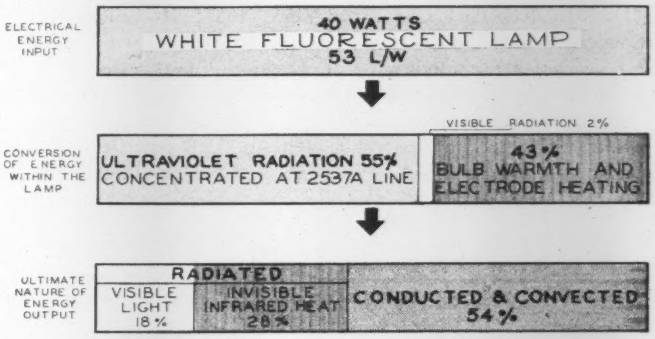
ELECTRICAL ENERGY INPUT
40 WATTS
WHITE FLUORESCENT LAMP
53 L/W
VISIBLE RADIATION 2%
CONVERSION OF ENERGY WITHIN THE LAMP
ULTRAVIOLET RADIATION 55%
CONCENTRATED AT 2537A LINE
43%
BULB WARMTH AND ELECTRODE HEATING
ULTIMATE NATURE OF ENERGY OUTPUT
RADIATED
VISIBLE LIGHT 18%
INVISIBLE INFRARED HEAT 28%
CONDUCTED & CONVECTED 54%
RADIATED ENERGY PER LUMEN $\frac{40 \times 0.46}{2120}$ = 0.0087 WATTS/LUMEN

Fig. 10—Distribution of the energy generated and emitted by a 40-w white fluorescent lamp

Summary

At the wattages per square foot for which it seems practical to air-condition today, the Type *F* lamps permit illuminations far in advance of those obtainable with Type *C* lamps because of their higher efficiency and because they can be used in systems having higher utilizations, such systems being made feasible by the lower brightnesses of the lamps. At these higher illuminations with Type *F* lamps there may be less heat effect per footcandle than for skylight—certainly less if the majority of the light passes through glass or plastic before reaching the room occupants. Furthermore, since the daylight and white lamps give psychologically cooler colors of light, we are indeed ready to enter the new era of a completely controlled environment—an environment with light, air and sound conditioning, an era of competing not with darkness but with daylight.

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Society Research Facilities Offered for National Defense

ACKNOWLEDGMENT was made on July 23, by Irvin Stewart, secretary of the National Defense Research Committee of the Council of National Defense, of Pres. F. E. Giesecke's offer of assistance through the Committee on Research of ASHVE, to further the defense program of the nation. It was pointed out by President Giesecke that the Society's Committee has been actively functioning for over 20 years in directing and coordinating fundamental research in the field of heating, ventilating and air conditioning, and that it had at its command comprehensive laboratory facilities with experienced personnel which places it in a position to offer material aid in the solution of engineering problems involving the control of atmospheric conditions, the elimination of toxic fumes and gases and the establishment of temperature and humidity standards wherever needed for national defense purposes.

In the nation-wide mobilization for national defense important problems confront the engineering profession and President Giesecke believes that full cooperation should be given by members to the efforts of leading engineering organizations which have sponsored a nation-wide census of engineers and architects skilled in the design and supervision of all types of construction needed in case of national emergency. The participating organizations are the *American Institute of Architects, American Society of Civil Engineers, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Mechanical Engineers,* AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, *American Society of Refrigerating Engineers, American Society of Military Engineers, American Institute of Consulting Engineers* and *National Society of Professional Engineers.*

The listing and classification of engineers is being carried on in the offices of *ASCE,* Engineering Societies Bldg., 29 West 39th St., New York, N. Y., and the architects at the headquarters of the *AIA,* Washington, D. C. This census is to determine those skilled in the design and supervision of construction of airports, water supply, purification plants, storage, and industrial waste disposal systems, roads, tunnels, port developments, industrial plant expansion, barracks, and the necessary mechanical, heating, ventilating and refrigerating systems.

The *American Engineering Council* through its president, A. J. Hammond, has placed all facilities of that organization at the command of the President, and F. M. Feiker, Executive Secretary, has indicated that a White House reply states that while, "it is still too early to assign a definite task the offer may be accepted in the future."

The *American Society of Mechanical Engineers* has announced a three-point program which includes an offer of the services of special committees of experts on production problems, the addition of 12 leaders of industry to its National Defense Committee and a general pledge of such aid as may be required.

The *Society of Automotive Engineers* has established a special committee to deal directly with defense problems.

The preparedness program continues to be the center of interest in Washington, as the National Defense Commission proceeds with its organization and the tremendous task of coordinating the plans to build up an adequate Army and Navy and furnish ample supplies of equipment for their use.

The defense commission has named a large number of advisory committees representing various phases of industry. Dr. Vannevar Bush, president of Carnegie Institute of Technology, is chairman of the National Defense Research Committee, which has been organized to "accelerate the creation or improvement of instrumentalities for national defense." Careful study is also being given to the matter of employment opportunities and the *Society for the Promotion of Engineering Education* is actively assisting in this program.

Other features of the program of particular interest to engineers are:

The Commissioner of Patents has been authorized to withhold the granting, and hence the publication of patents on devices relating to national defense.

The Census Bureau will give priority to the production of statistics useful in defense in analyzing returns from the 1940 census.

The United States Housing Authority will utilize its experience in the construction of low-cost housing for slum areas to take over the task of building living accommodations for civil and military personnel. It has on hand $180,000,000 available for this purpose.

In Washington, a new building now being completed for the Social Security Board will be turned over, instead, to the National Defense Commission and the War Department. In addition, Congress has been asked to approve the construction of two new office buildings containing 1,100,000 sq ft of space at a cost of $7,700,000.

Air Flow Measurements at Intake and Discharge Openings and Grilles

By G. L. Tuve* and D. K. Wright, Jr.** (*MEMBERS*), Cleveland, Ohio

This paper is the result of research sponsored by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS in cooperation with Case School of Applied Science

Summary

TO OBTAIN true air velocity or volume from the readings of air velocity meters, an *application factor* must be applied in addition to the corrections for instrument calibration.

For rotating vane-wheel anemometers, the recommended application factors for most conditions are 0.85 for air inlet openings, and 1.03 for air discharge openings. For the velometer used at air discharge openings an approximate application factor of 0.93 is recommended. The limitations of these factors are given in Tables 1 and 2. These two tables are the result of correlations between the 1000 or more instrument traverses here reported and the data presented elsewhere by several other investigators.

The influence of each of six important variables upon instrument readings is discussed, for both air intake and air discharge openings.

Definitions: True Velocity vs Instrument Reading

The air velocity across the face of an opening is not uniform, in fact a wide range of velocity readings can frequently be obtained.[1] Since an air intake or an air discharge opening is usually a contracted section, the velocity varies both at right angles to the flow and in line with it. A velocity reading refers to a single location, and the reading will probably change if the instrument is moved either from side to side or in or out.

But there are no instruments for measuring air velocity at a *point*, because an instrument, tube or jet will occupy an appreciable area across the face. The instrument will also be affected by other conditions, such as pressure or temperature, as well as by velocity. Hence the velocity pattern obtained will depend on what instrument is used. If an average velocity is required, an arbitrary method of averaging must be agreed upon. If the average velocity is to be multiplied by an area to obtain volume, that area must be clearly defined or designated.

The following statements and definitions are in accord with the general practices of many test engineers, and will be used for the purposes of this investigation:

Location of Instrument: If the opening is covered with a grille, the instrument should touch the grille face, but should not be pushed in between the bars. For a free opening without a grille, guide wires should be stretched across the plane of the opening and the instrument held in the plane of the guide wires. The anemometer must always be held in such a manner that the air flow through the instrument is in the same direction as was used for calibration (usually from the back toward the dial face). An instrument, tube or jet should be held in place

Table 1—Application Factors for General Use of Anemometers and Velometers

	APPLICATION FACTORS	
	ANEMOMETER 3 IN. TO 6 IN. SIZES VELOCITY 400-1500	VELOMETER SPOT JET OR AVERAGING JET VELOCITY 600-1500
AIR INTAKE OPENINGS (ROOM EXHAUST) Any size or shape of rectangular intake more than 4 in. wide and up to 600 sq in. with flange at least 2 in. wide, either free-open or with grille with free opening 60 per cent or more of the core area:	0.85	Not recommended
AIR DISCHARGE OPENINGS (ROOM SUPPLY) Any size or shape of rectangular discharge opening more than 4 in. wide and up to 600 sq in. area, with length of approach duct at least equal to twice the smaller side, and with free opening 70 per cent or more of the core area, no directional vanes:	1.03	0.93

EQUATION FOR USE:

$$\text{True Volume, cfm} = \left\{\begin{matrix}\text{Application}\\ \text{Factor}\end{matrix}\right\} \times \left\{\begin{matrix}\text{Av. Velocity}\\ \text{by Instrument}\end{matrix}\right\} \times \left\{\begin{matrix}\text{Designated}\\ \text{Area}\end{matrix}\right\}$$

Designated Area for intakes = Core area.
Designated Area for discharge openings with anemometer = average between core area and free-open area at the plane of the near face.
Designated Area for discharge openings with velometer = free-open area.
Average velocity by instrument is obtained from equal-time traverse of 4 in. squares, corrected for instrument calibration.
Note: For data on accuracy of these application factors, see text.

Table 2—Correction Factors

For low air velocities or very large openings, the instrument application factors given in Table 1 should be multiplied by the following additional correction factors.

AIR VELOCITY CORRECTION

VELOCITY BY INSTRUMENT, FPM	ROTATING VANE ANEMOMETER		VELOMETER
	FACTOR FOR INTAKE	FACTOR FOR DISCHARGE	FACTOR FOR DISCHARGE
700	1.00	1.00	1.02
600	1.00	1.00	1.05
500	1.00	1.01	1.09
400	1.01	1.03	1.15
300	1.03	1.06	1.22
200	1.07	1.10	....

SIZE CORRECTION
(*For Intakes*)

AREA OF INTAKE OPENING SQ IN.	CORRECTION FACTOR
500	1.01
1000	1.07
1500	1.14
2000	1.16

Caution Approach Conditions:
The factors given in Tables 1 and 2 *do not* apply to duct-end intakes without flanges or to discharge openings in thin-walled plenum chambers.

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[1] See Fig. 10.

Presented at the Semi-Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Washington, D. C., June, 1940.

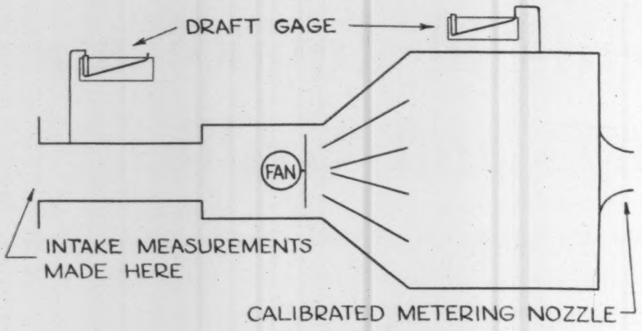

Fig. 1—Diagram of test unit for air intake studies

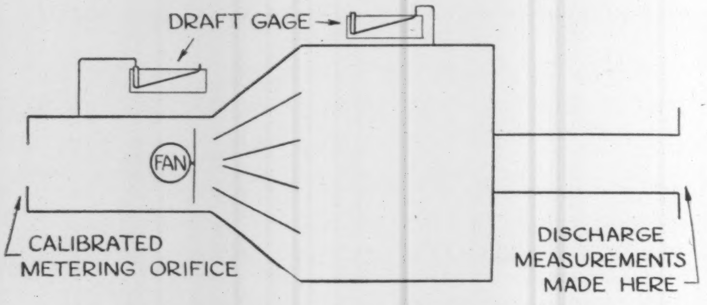

Fig. 2—Test set-up for study of air discharge openings

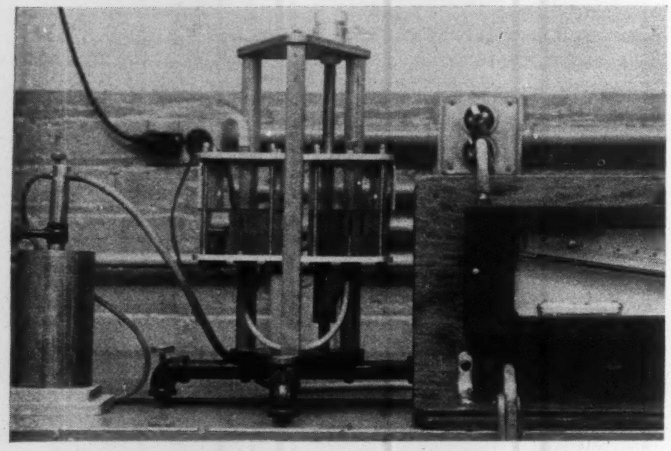

Fig. 3—Hook-gage micromanometer used for draft gage calibrations

by means of a thin handle ($\frac{1}{2}$ in. in diameter or less) and the hands and body of the observer should be entirely outside the area of flow. A string and rubber band may be used for starting and stopping the totalizer.

Average Velocity by Instrument: The total rectangular opening or core area is to be divided into squares or rectangles 3 in. to 5 in. on a side, and the average velocity by instrument will be the arithmetical average of the readings in these squares. Totalizing instruments may be moved from one square to another without stopping the totalizer, but an interval of at least 10 seconds in each square is recommended.

True Average Velocity: The true average velocity is obtained by dividing the true volume of air in cfm by the designated area in square feet. (In calibration tests the true volume of air is measured by an independent meter of approved accuracy.) The true average velocity is also obtained as the product of the application factor and the average velocity by instrument.

Designated Area: (a) For air *intake* openings, the designated area is the core area, or the total area within a rectangle drawn through the outer edges of the outer openings. (b) For air *discharge* or outlet openings, the designated area may be either the free area or the arithmetical average of the core area and the total free-open area at the plane of the near face, depending on the instrument used, as in Table 1.

Application Factor: The application factor is the factor by which the average velocity by instrument is to be multiplied to obtain the true average velocity.

Equations:

$$\left(\begin{array}{l}\text{Average velocity by}\\ \text{instrument, fpm.}\end{array}\right) \times \left(\begin{array}{l}\text{Application}\\ \text{Factor}\end{array}\right) = \left(\begin{array}{l}\text{True Average}\\ \text{Velocity}\end{array}\right)$$

$$\left(\begin{array}{l}\text{True average}\\ \text{velocity, fpm.}\end{array}\right) \times \left(\begin{array}{l}\text{Designated}\\ \text{area, sq ft}\end{array}\right) = \left(\begin{array}{l}\text{True}\\ \text{Volume cfm.}\end{array}\right)$$

Instrument Calibrations and Test Methods

The velocity instruments (anemometers and velometers) used in this investigation were new instruments, calibrated before and after the tests by the methods described in a previous paper.[2] To obtain instrument readings, the calibration corrections were applied in all cases. Calibrations in a wind tunnel were taken as standard for the velometers, and calibrations by a 10-ft rotating arm were used for the anemometers. With an arm length of 10 ft or more, the agreement between the two methods is within about 2 per cent.

The test equipment for air intakes is shown in Fig. 1 and that for air discharge openings is shown in Fig. 2. The primary air measurement was by calibrated nozzles and orifices, which had been checked against each other and against impact-tube and pitot-tube traverses with an accuracy closer than 1 per cent. Inclined manometer gages, calibrated within 0.001 in. of water were used for measuring impact pressures and differential pressures, the calibration standard being the water-filled precision hook gage shown in Fig. 3. This gage could be read to the nearest 0.0005 in. of water. Plenum and duct pressures were always measured by two independent gages, each connected to a different set of pressure taps. All ducts and plenum boxes were carefully sealed, and were calibrated for leakage both before and after the tests.

The question of what test methods to use in the determination of instrument application factors requires some analysis of stream characteristics as well as of instruments. When an air stream flows through a contracted section such as an orifice, a nozzle or a grille, the drop in static pressure and the increase in velocity do not take place instantaneously. On the contrary, an appreciable length or distance in the direction of flow is required for the minimum downstream pressure to be reached and the maximum downstream velocity attained. Similarly, the velocity distribution across the stream varies with the type and length of approach.

Apparently then, none of the common instruments (except a modified pitot tube), will measure true velocity, because the pressure gradients and the velocity gradients are not properly accounted for. The instrument application factor must therefore compensate for these

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[2] ASHVE Research Report—The Use of Air Velocity Meters, by G. L. Tuve, D. K. Wright, Jr. and L. J. Seigel. (ASHVE Transactions, Vol. 45, 1939.)

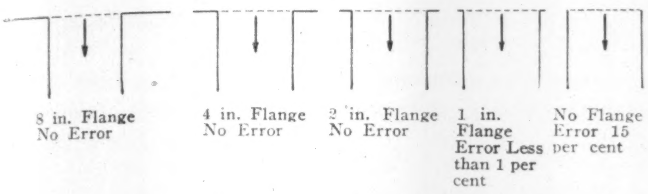


Fig. 4—Test results showing effect of width of flange on accuracy of anemometer factor recommended in Table 1. Tests on 12-in. square intake

gradients, as well as for the defects inherent in the instrument when it is used in non-uniform streams. And finally, this application factor must be based on rigid and arbitrary methods of calibrating and using the instrument, especially if average velocity is required. These difficulties lead to the simple definition of the application factor as the true metered volume divided by the instrument reading (or the average of several readings). For rectangular openings, which are the only ones considered in this paper, the area is abitrarily divided into small squares or rectangles 3 in. to 5 in. on a side, and a reading is taken in each. The instrument calibration is then applied.

If the rotating arm method can be used for calibrations, it is by far the easiest and most consistent for velocities below 1000 fpm. If a wind tunnel is to be used, it must have a long smooth inlet nozzle, with supply from a very large duct or plenum or from the atmosphere in a quiet room. The readings must be taken far enough downstream to obtain the maximum velocity. Under no circumstances should air velocity meters be calibrated in a fan duct, or in the discharge from a duct or pipe, or from a square-edged orifice or a short-type nozzle. There is no satisfactory way of checking the errors produced in these latter cases.

Variables Affecting Instrument Readings

Six major variables affect the reading of a velocity meter when it is applied to either an air intake or an air discharge opening:

1. Type of approach to the opening.
2. Total area of opening.
3. Shape of opening, or dimension ratio.
4. Air velocity.
5. Type, size and position of instrument.
6. Screen or grille, if any.

Each of these six factors has been investigated in turn, first for air intakes, then for air discharge openings.

Air Intake Openings

Room Exhaust

All intake openings move air by a conversion of static pressure to velocity. Hence a suction or vacuum exists in or near an air intake, and the impact-type of measuring instrument such as an impact tube or a velometer jet reads *zero* when placed in an intake opening facing against the stream. The reversed tube, facing downstream, is unsatisfactory because of the shape-factor. The common pitot tube is also unsatisfactory, because its impact and static openings are too far apart and because low-velocity measurements are very difficult. The rotating vane-wheel anemometer reads too high in most cases, but its readings are highly consistent and it is the most convenient instrument to use. An investigation of the use of the anemometer at intake openings has therefore been made.

An air intake opening in a wall is essentially the upstream side of a flat-plate orifice, or of many orifices side by side. The jet contraction which takes place with flow through such an orifice affects the readings of an anemometer traverse. If the air intake is at the end of a thin-walled duct, with no flange at the entrance, the flow pattern will be entirely different, and hence a different anemometer application factor must be used. An intake

Table 3—Data on Anemometer Measurements at Air Intakes

Size of Opening	Type of Approach	Size of Anemom. In. Dia.	No. of Traverse Positions	No. of Complete Traverses	No. of Test Velocities	Velocity Range, Fpm	Average Anemom. Application Factor, F	Percentage Deviation From Avg F	
								Mean	Max.
				Effect of Size of Opening					
14x5	Wide Flange	4	4	15	5	435–1215	0.854	0.5	1.0
14x6	Wide Flange	4	8	12	4	610–1205	0.840	0.1	0.5
14x8	Wide Flange	4	8	23	7	440–1350	0.856	2.2	3.3
14x10	Wide Flange	4	12	24	8	445–945	0.860	0.5	1.5
24x5	Wide Flange	4	6	20	6	595–1230	0.864	0.7	1.0
8½x8½	Wide Flange	4	4	19	6	565–1360	0.856	0.8	1.6
12x12	Wide Flange	4	9	28	9	444–932	0.834	0.4	1.0
18x18	Wide Flange	4	16	3	1	274	0.864	—	—
24x24	Wide Flange	4	36	9	3	319–370	0.880	0.4	0.6
30x42	Wide Flange	4	80	7	3	460–580	0.973	0.9	1.3
36x50	Wide Flange	4	70	10	2	575–630	0.995	—	0.5
				Effect of Flange					
12x12	8" Flange	3	16	12	4	470–935	0.834	0.2	0.6
12x12	4" Flange	4	9	28	9	444–932	0.834	0.4	1.0
12x12	2" Flange	4	9	25	8	336–933	0.837	0.7	2.1
12x12	1" Flange	4	9	25	7	330–940	0.840	1.3	2.9
12x12	Duct End—No Flange	4	9	16	5	313–893	0.716	0.5	0.8
				Effect of Low Velocities					
24x24	Wide Flange	4	36	3	1	130	0.985	—	0.0
24x24	Wide Flange	4	36	3	1	178	0.938	—	0.2
24x24	Wide Flange	4	36	3	1	228	0.910	—	0.0
24x24	Wide Flange	4	36	3	1	267	0.895	—	0.0
24x24	Wide Flange	4	36	3	1	319	0.885	—	1.1
24x24	Wide Flange	4	36	3	1	352	0.880	—	0.5
24x24	Wide Flange	4	36	3	1	370	0.880	—	0.0
				Effect of No. of Traverse Positions					
12x12	Duct End—No Flange	3	1	18	6	340–995	0.827	0.8	1.4
12x12	Duct End—No Flange	3	4	21	6	450–955	0.743	0.1	0.4
12x12	Duct End—No Flange	3	9	29	9	304–985	0.717	1.4	4.2
12x12	Duct End—No Flange	3	16	43	15	316–954	0.719	0.9	2.5
12x12	Wide Flange	3	4	12	4	440–955	0.879	0.6	1.0
12x12	Wide Flange	3	16	12	4	470–935	0.834	0.2	0.6
				Effect of Anemometer Size					
12x12	Duct End—No Flange	6	4	29	8	390–994	0.723	0.6	1.5
12x12	Duct End—No Flange	4	9	16	5	313–893	0.716	0.5	0.8
12x12	Duct End—No Flange	3	16	43	15	316–954	0.719	0.9	2.5
12x12	Wide Flange	4	9	28	9	444–932	0.834	0.4	1.0
12x12	Wide Flange	3	16	15	5	357–935	0.837	0.7	1.8
24x8	Flange and Grille	3	12	6	2	399–839	0.876	—	1.1
24x8	Flange and Grille	4	12	6	2	618–1000	0.888	—	0.2
				Effect of Grille					
24x8	Bar Grille and Flange	3 and 4	12	12	4	400–1000	0.882	0.6	1.6
20x8	Sq Punched Grille	4	10	14	4	540–1460	0.780	0.5	2.0
12x6	Sq Punched Grille 71% Free Area	4	6	15	5	700–1050	0.874	0.8	1.6
12x6	Bar Grille and Flange	4	6	33	11	640–1080	0.856	1.6	3.4
14x10	Screen—½" Mesh—85% Free Area	4	12	15	5	660–1210	0.857	0.6	1.2

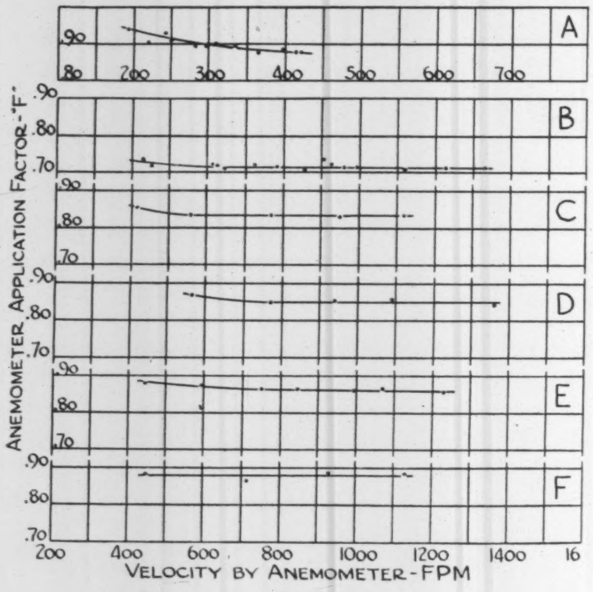
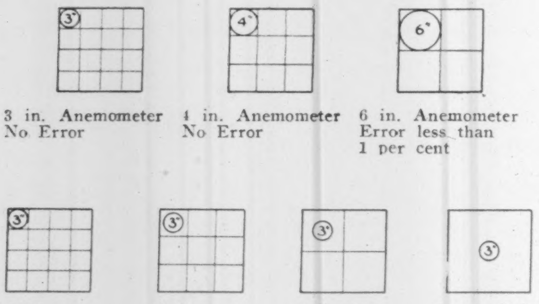


Fig. 5—Typical curves of application factor vs air velocity for air intakes

A—24 in. sq flanged open duct
B—12 in. sq sharp-edged open duct
C—12 in. sq flanged open duct
D—8½ in. sq flanged open duct
E—5 in. x 24 in. flanged open duct
F—8 in. x 24 in. low resistance grille



3 in. Anemometer No Error
4 in. Anemometer No Error
6 in. Anemometer Error less than 1 per cent

16 Squares No Error
9 Squares No Error
4 Squares Error 4 per cent
Center Only Error 12 per cent

Fig. 6—Test results showing effect of size of anemometer and number of traverse positions on accuracy of anemometer factor recommended in Table 1. Tests on 12-in. square intake

opening with a flange is intermediate between a wall opening and an open-end duct, but unless the flange is very narrow it acts like a wall opening, as is demonstrated by the test data of Fig. 4 (see also Table 3).

The shape and size of an air intake opening has less effect than might be expected. If the opening is over 4 in. wide and not more than 400 sq in. in area, the anemometer application factor remains constant at about 0.85. Examples from tests are given in the first section of Table 3. For intake openings of 500 sq in. or more, the application factor increases due to less *edge effect,* (see Fig. 10), and a correction factor from Table 2 should be applied.

In the velocity range from 400 to 1500 fpm the anemometer application factor is practically constant, as is shown by the typical traverses of Fig. 5, as well as by the deviations listed in Table 3 covering about 500 traverses. For air velocities below 500 fpm the application factor increases, and a correction must be applied as given in Table 2.

The size of anemometer has little effect as long as the traverse squares are nearly the same size as the anemometer diameter. Results of tests in a 12-in. square intake, with three sizes of anemometers and with 1 to 16 traverse positions are shown in Fig. 6.

Some anemometers have a convex cover-glass over the dials which will not allow the shroud ring to touch the grille face. These instruments are not properly designed for air intake measurements and errors of the order of 5 per cent are produced. But accurate readings may be obtained by fitting an extension on the shroud ring to bring it flush with the cover glass. (An extension may be improvised by using paper masking tape.)

When screens or low-resistance grilles are used to cover an air intake, the anemometer application factor is practically the same as for a free intake. Tests were made on various sizes of intake grilles and screens, including a square-punched grille of 71 per cent free area, three or four types of bar grilles having 75 per cent to 90 per cent free area and a ½-in. mesh wire screen of about 85 per cent free area. In almost all cases the anemometer application factors were within 3 per cent of the selected factor of 0.85, (see Table 3).

Air Discharge Openings

Room Supply

The problem of the air discharge opening is more complicated than that of the air intake for three reasons: (1) More types of instruments are available for air discharge measurements. (2) Conditions of the approach to an air outlet are highly variable. (3) Many kinds of grilles and registers are in common use.

In the matter of instruments, the present investigation has been confined to the anemometer and the velometer, which are the two most common. It is admitted that one or more of the heated type instruments might be used, but some of these require more time for the taking of readings, and the first cost of the quick-reading types is rather high. Tests were made with three kata-thermometers, at air velocities from 200 to 2000 fpm, but, due to inconvenience in reading and to uncertainty in calibration, the use of these instruments was discontinued.

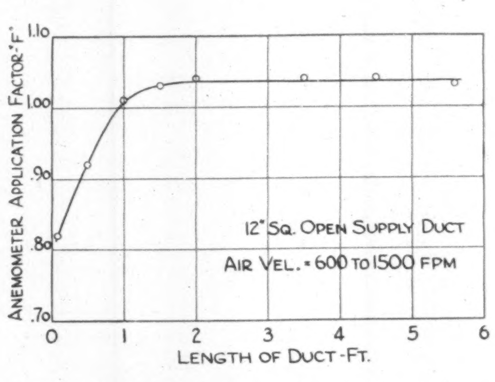


Fig. 7—Effect of length of approach to air discharge openings

(*Note:* Each point represents 12 traverses at 4 air velocities)

Using the anemometer and the velometer, the position and method of traverse were again arbitrarily fixed, by using small (3 in. to 5 in.) squares or rectangles and taking a reading at the center of each. Any size of anemometer, 3-in. to 6-in., and either the spot jet or the averaging jet for the velometer, may be used in this traverse method with practically the same results.

The approach condition upstream from the opening is the variable having the greatest effect upon the instrument factor for air discharge or room supply openings. In fact, if approach conditions cannot be controlled, the air measurements by traverse with a velocity-type meter are only roughly approximate.

The two extreme conditions of the approach are: (1) A very long, straight approach duct, and (2) a large thin-walled plenum chamber with a square-edged opening. In the first case the approach velocity is a maximum; in the second case the approach velocity is zero and all the velocity is generated at the opening itself. When either an anemometer or velometer is used to traverse such a square-edge opening in a plenum or large duct the instrument reading will be high, and an application factor of 0.65 to 0.75 must be applied to obtain the average velocity. The use of an application factor in this case is rather unsatisfactory, because it is greatly affected by edge conditions and by the presence of even a narrow flange or frame.

For a duct-type approach approximately the same size as the opening, the application factor is near unity for the anemometer and from 0.87 to 1.01 for the velometer. Tests were made to determine the necessary length of approach duct to produce a constant application factor for the instruments. Starting with a 12 in. x 12 in. duct 67 in. long, this duct was cut off 7 times, until only a 1-in. long stub remained for the 8th test. The results are shown in Fig. 7 and in Tables 4 and 5. In this case a length of straight approach duct of 1.5 diameters or more was necessary to produce a consistent application factor.

The effect of variations in the air velocity upon the instrument application factor is negligible as long as the velocity is within the range of 500 to 1500 fpm for the anemometer or 700 to 1500 fpm for the velometer. This is shown by the typical test curves of Figs. 8 and 9. For air velocities lower than these, the application factors increase, and corrections must be made as given in Table 2. These correction factors were obtained by replotting a large number of test curves like those in Figs. 8 and 9.

Table 4—Data on Anemometer Measurements at Air Supply Openings

Size of Opening	Type of Approach	No. of Traverse Positions	No. of Complete Traverses	No. of Test Velocities	Velocity Range Fpm	Average Anemom. Application Factor F	Percentage Deviation From Avg F		
							Mean	Max.	
EFFECT OF SIZE OF FREE OPENINGS									
14x5	24" long Straight Duct 8' long	8	31	10	450–1100	1.04	1.1	3.4	
14x8		8	24	8	600–1500	0.99	0.6	1.0	
14x10		12	12	4	650–1200	1.02	0.9	2.7	
12x12		16	12	4	550–1400	1.04	0.5	1.9	
24x8		16	9	3	600–1200	1.03	0.2	0.3	
24x24		64	12	4	500–700	1.02	0.4	1.0	
EFFECT OF LOW VELOCITY—SEE TABLE 2.									
EFFECT OF LENGTH OF APPROACH (*Free Openings*)									
12x12 Straight Open Duct	1" long	16	15	5	500–1400	0.82	0.4	0.6	
	6" long	16	12	4	600–1400	0.92	0.7	1.1	
	12" long	16	12	4	550–1200	1.01	0.9	1.5	
	18" long	16	12	4	600–1400	1.03	0.3	0.5	
	24" long	16	12	4	550–1400	1.04	0.5	1.9	
	42" long	16	12	4	550–1400	1.04	1.0	2.0	
	52" long	16	12	4	550–1400	1.04	0.9	1.3	
	67" long	16	12	4	600–1400	1.03	0.6	1.3	
EFFECT OF GRILLES									F Based on Mean Area
20"x8" Sq. Punched 71 % Free Area		10	15	5	500–1400	1.19	1.7	2.5	0.99
24"x8" V-Bar 76 % Free Area		14	12	4	550–1400	1.19	0.4	1.0	1.02
24"x8" H-Bar 85 % Free Area		16	12	4	500–1300	1.17	0.7	0.8	1.08
12"x6" H-Bar 78 % Free Area		9	12	4	300–1300	1.14	—	—	1.01
(*Approach to Grilles: Nominal Size Rectangular Duct—2 ft long.*)									
TESTS ON PLENUM OPENINGS									
18x6 Plenum		10	15	5	300–1600	0.67			—
12x6 Plenum		6	15	5	700–1700	0.73			—
12x6 Bar Grille ½" centers, 78 % F.A.		6	12	4	250–500	1.07			0.95
18x6 Bar Grille 79 % F. A.		10	12	4	600–1100	1.03			0.92
20x8 Bar Grille 79 % F. A.		12	27	9	250–800	1.02			0.91
24x8 Bar Grille ¼" centers, 76 % F.A.		16	33	11	400–1400	1.01			0.88

Table 5—Data on Velometer Measurements at Air Supply Openings

Size of Opening	Type of Approach	Type of Jet Used	No. of Traverse Positions	No. of Test Velocities	Velocity Range Fpm	Average Velom. Application Factor, F	Percentage Deviation From Avg F		Factor F for Center Reading Only
							Mean	Max.	
EFFECT OF SIZE OF FREE OPENINGS									
14x5	24 in. Long Straight Duct 8' long	Averaging	4	7	800–1600	0.92	1.5	4.0	0.90
14x8		Averaging	8	7	700–1500	0.94	2.8	4.2	0.88
14x10		Averaging	12	4	750–1300	0.92	0.8	1.1	0.86
12x12		Averaging	16	9	700–1600	0.89	1.1	2.3	0.86
24x8		Spot & Avg	16	7	700–1400	0.93	1.5	2.2	0.87
24x24		Averaging	64	1	750	0.94	—	—	0.87
EFFECT OF LOW VELOCITY—SEE TABLE 2.									
EFFECT OF LENGTH OF APPROACH (*Free Openings*)									
12x12 Straight Open Duct	1" long	Avg	16	4	800–1600	0.67	1.1	1.5	0.65
	6" long	Avg	16	4	700–1400	0.81	1.2	1.2	0.76
	12" long	Avg	16	3	800–1300	0.87	1.1	1.1	0.82
	18" long	Avg	16	3	860–1600	0.92	1.4	2.2	0.86
	24" long	Avg	16	9	700–1600	0.89	1.1	2.3	0.86
	42" long	Avg	16	3	800–1500	0.93	1.1	2.1	0.87
	52" long	Avg	16	4	750–1500	0.87	1.5	3.5	0.85
	67" long	Avg	16	4	800–1600	0.86	0.9	2.3	0.85
EFFECT OF GRILLES									
20"x8" Sq. Punched 71 % Free Area		Spot	10	5	700–1800	0.88	2.1	3.5	0.86
24"x8" V-Bar 76 % F. A.		Spot	16	4	700–1600	1.01	2.5	5.0	1.00
24"x8" H-Bar 85 % F. A.		Spot	16	4	700–1500	1.01	1.0	2.0	0.97

(*Approach to Grilles: Nominal Size Rectangular Duct—2 ft long.*)

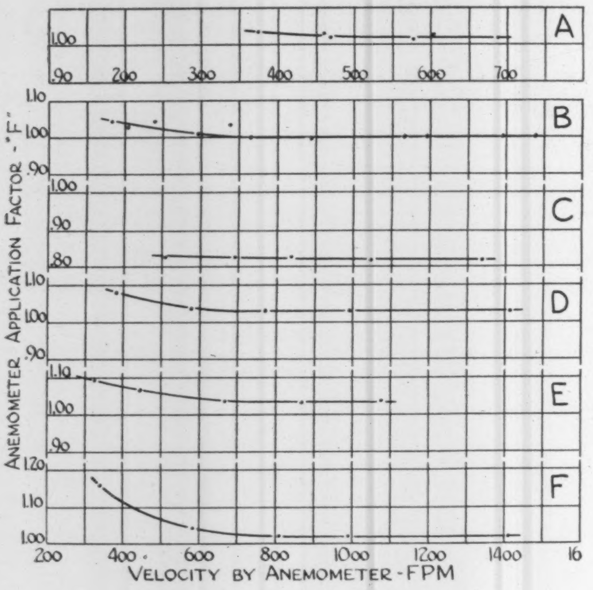


Fig. 8—Typical curves of application factor *vs* air velocity for air discharge openings

A—24 in. sq open duct
B—14 in. x 8 in. open duct
C—12 in. sq open duct—1 in. long
D—12 in. sq open duct—18 in. long
E—24 in. x 8 in. open duct
F—24 in. x 8 in. low resistance grille

The size and shape of the openings have little effect on the instrument application factor for air discharge or supply openings, as long as the width is 4 in. or more and the area does not exceed 600 sq in. No tests were made on discharge openings larger than 24 in. x 24 in.

The effect of grilles covering air discharge or supply openings is to make the instruments read low if the calculations are based on the free area only. The method of using the average between the free area and the core area, which was originated by Davies[3] and is recommended by The Guide 1940 (p. 770), gives instrument application factors near unity for the anemometer. For the velometer on the other hand, the advantage of using the average is questionable, (see Tables 4 and 5).

Conclusions and Correlations

The general conclusions from these studies are that the rotating vane anemometer can be relied upon for air volume measurements with an accuracy of 3 per cent or closer, if the measurements are made at a free-open intake (with flange) or at a free-open discharge from a long duct. When the opening is covered with a grille or screen the results are not as reliable, but an accuracy of 5 per cent can be expected, both for flanged intakes and for discharge or supply openings which have an approach duct at least 2 diameters in length. The instrument factor is little affected by the area or the shape of the opening, by the instrument size or by the air velocity (above 500 fpm). For comparative measurements the anemometer is highly accurate,—within 1 per cent or less.

Perhaps the most important result of these tests has been to demonstrate that errors as great as 15 per cent to 30 per cent may be caused by neglecting the effect of approach conditions. The anemometer factor for an air intake may change from 0.85 to 0.72 if the flange is omitted. The factor for both anemometer and velometer, applying to an air discharge grille, may be reduced 15 to 30 per cent if the grille is moved from a location at the end of a long duct to a location in the wall of a plenum chamber.

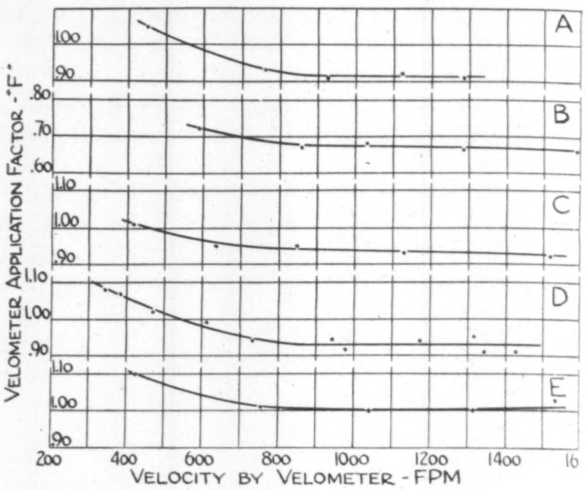


Fig. 9—Typical curves of velometer application factor *vs* air velocity for air discharge openings

A—14 in. x 10 in. open duct
B—12 in. x 12 in. open duct—1 in. long
C—12 in. x 12 in. open duct—3½ ft long
D—24 in. x 8 in. open duct
E—24 in. x 8 in. low resistance grille

The velometer is an excellent instrument for instantaneous readings, but the fluctuations inherent in a turbulent air stream make it difficult to determine the average velocity by the use of any instrument of the instantaneous indicating type. Snap readings in the center of an air supply opening can probably be relied upon just as closely as the traverse readings, if the velocity distribution across the opening is good. Table 5 shows that a factor of 0.86 applied to the center reading gave results within 2 per cent for 11 out of 14 openings. Momentary fluctuations and poor distribution will affect this factor however, and it is also in error by as much as 15 per cent for certain types of grilles. More work should be done to investigate thoroughly the advantages and the limitations of the valuable instantaneous-type instruments such as the velometer and the hot-wire devices.

Correlations and Comparisons

The Guide 1939 recommended 0.873 for the anemometer application factor for air intakes or room exhaust grilles for all usual velocities. This was based on the work of Greene and Dean.[4] The Guide 1940 recommends a factor of 0.80 for average conditions. This was based on the earlier work of Davies. A re-analysis of the data given in these two papers gives the results presented in Table 6, covering air intake openings. Davies' work included very low velocities and some grilles of very high resistance. Averaging all the original data given in the Davies papers which apply to velocities above 300 fpm and to grilles of more than 50 per cent free area, the anemometer factor is 0.836. The differ-

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[3] ASHVE Research Report No. 857—The Measurement of the Flow of Air Through Registers and Grilles, by L. E. Davies. (ASHVE Transactions, Vol. 36, 1930, p. 201.) (See also No. 911, Vol. 37, 1931 and No. 966, Vol. 39, 1933).

[4] The Flow of Air Through Exhaust Grilles, by A. M. Greene Jr. and M. H. Dean. (ASHVE Transactions, Vol. 44, 1938, p. 387.)

Table 6—Comparison of Anemometer Factors from Various Sources

REPORTED BY	APPROX. NO. OF TRAVERSES	NO. OF SIZES OF OPENINGS	NO. OF GRILLES	VELOCITY RANGE	AVERAGE FACTOR	AVERAGE DEVIATION PER CENT
AIR INTAKES OR ROOM EXHAUST, WALL OR FLANGE-TYPE OPENING						
Davies	20	1	6	330–700	0.836	2
Greene and Dean	67	4	20	230–1000	0.873	3
Tuve and Wright	306	12	5	400–1500	0.85	2
AIR DISCHARGE OR ROOM SUPPLY—LONG DUCT APPROACH						
Davies	17	2	5	300–750	0.99	1.5
Larson, Nelson and Kubasta	4	1	1	300–900	1.00	0.3
Tuve and Wright	212	8	4	450–1500	1.03	1.5

ence between this value and the 0.85 obtained in the present investigation is probably due mainly to the narrow flange used by Davies around the grilles he tested. Part of the difference may be due to anemometer calibrations, as Davies reported 6 per cent difference between two of the anemometers he tested. Greene and Dean show about 67 plotted points in their Fig. 17, and they give an average anemometer factor of 0.873. Their special traverse method gave the middle zone of the grille a value four times that of the top and bottom zones. Since the anemometer actually reads *highest* in the corners, as shown by the test data of Fig. 10, any method which slights these corner values would result in an anemometer factor nearer unity. From these evidences it is concluded that for an equally-timed traverse the new factor of 0.85 is substantiated by previous work and that it is well proven by tests on at least 30 different grilles, for the velocity range above 300 fpm. For velocities below 300 fpm there is a sharp contradiction in the findings of the three investigations, and further tests should be made.

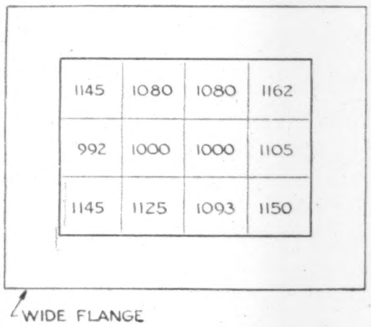

Fig. 10—Typical distribution of anemometer velocity readings at an air intake

Velocities as read by anemometer in a traverse of a 14 in. x 10 in. flanged air intake with a 4-in. anemometer. (Total 36 readings, 2 min each)

For air discharge or supply openings, THE GUIDE 1940 recommends an anemometer factor of 1.00 for velocities above 600 fpm and 0.97 for the range 150-600 fpm, using the arithmetical mean of the core area and the net free area as the multiplier to obtain volume. These were the Davies results, and they were based on a long duct approach. A re-analysis of the data at present available on air outlets in the range of velocities above 300 fpm, is given in Table 6. While the data on grilles are not entirely adequate, the anemometer coefficient for a free opening is evidently above unity. There is again a complete disagreement regarding the factors to be applied at velocities below 300 fpm.

A calibration factor of unity has also been reported for an outlet grille mounted on an elbow or stack head,[5] although this factor probably depends on the character of the stack-head installation.[6] A series of additional tests on stack heads is being conducted under the direction of the ASHVE Technical Advisory Committee on Air Distribution and Air Friction at the University of Wisconsin by Prof. D. W. Nelson and will no doubt furnish ample data on such outlets.

Further Investigation

It would be profitable to extend the study of this subject to obtain more data in the range of velocities below 300 or 400 fpm, and also to test a few more arrangements of supply grilles. Since the cooperative projects at the Universities of Wisconsin and Illinois deal with air flow through stack heads and room supply outlets, further data will be available on this subject very soon.

The next major step in the study at Case School of Applied Science will be to extend the measurements into the room space, investigating both the primary and the induced air motion. Tests already made have shown that for the same size of opening and the same volume of primary air, a stream issuing from a square-edged plenum opening will have a longer throw than a stream from a straight duct, and that there is also considerable difference in the quantity of air entrained in the two cases.

The velometer and the hot-wire anemometer are especially well suited for these studies of free air streams, and supplementary data will be collected on these valuable instruments. The subject of grille performance will be studied, and the entire investigation will ultimately focus on the measurements of air velocities and drafts within the occupied zone of the room.

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[5] ASHVE RESEARCH REPORT No. 936—Investigation of Air Outlets in Classroom Ventilation, by G. L. Larson, D. W. Nelson and R. W. Kubasta. (ASHVE TRANSACTIONS, Vol. 38, 1932, p. 463.)

[6] Investigation of Warm-Air Furnaces and Heating Systems, by A. C. Willard, A. P. Kratz and V. S. Day. (University of Illinois, *Engineering Experiment Station Bulletin* No. 120, p. 97.)

Carrier's Igloo at New York World's Fair Offered to City for Park

J. I. Lyle, president of Carrier Corp., Syracuse, N. Y., manufacturers of air conditioning equipment, has announced that the Carrier Igloo of Tomorrow at the New York World's Fair was offered as a gift to the City of New York for use as a permanent unit of Flushing Meadows Park, after the close of the Fair on October 31, 1940. Mr. Lyle stated that the building would be suitable for use as a museum, aquarium or aviary, and that its unusual design would make it an attractive addition to the proposed park. He further explained that the interior was constructed so that only minor structural changes would be necessary for its conversion to park purposes.

Paul S. Morton Announces New Office

Mr. Morton announces the opening of a new contracting engineering office in his name at 609 Bangor Rd., Lawrence, Mich. He was formerly sales engineer for the Automatic Heating and Cooling Supply Co., Chicago, Ill.

F. E. Giesecke, College Station, Tex.
President—1940

Proceedings of the Semi-Annual Meeting 1940

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Wardman Park Hotel—Washington, D. C.
June 17-19, 1940

THE Society's Semi-Annual Meeting 1940 attracted a large attendance at the Wardman Park Hotel, Washington, D. C., June 17-19, when 341 members, ladies and guests were registered. Prior to the official opening of the meeting, the Council, the Committee on Research and many technical advisory committees held meetings, and throughout the 3-day sessions there were many special committee meetings, so that the business and technical affairs of the Society were reviewed and plans were approved for new research projects, future meetings and many other activities.

FIRST SESSION—

Monday, June 17, 10:00 a. m.

Pres. F. E. Giesecke called the meeting to order on Monday, June 17, in the Continental Room and a brief message of greeting was given by T. H. Urdahl, general chairman of Committee on Arrangements of the Washington D. C. Chapter. He expressed the pleasure of the Washington members for the splendid attendance and extended the hospitality of the Washington members to the visiting members and guests. President Giesecke responded briefly on behalf of the Officers and members of the Society.

The first speaker was F. C. Houghten, director of the Society's Research Laboratory, who presented his paper entitled Summer Cooling Load as Affected by Heat Gain Through Dry, Sprinkled and Water Covered Roofs (complete paper published in July 1940 ASHVE JOURNAL SECTION, *Heating, Piping and Air Conditioning*). Some of the practical applications of the data developed were discussed by Messrs. E. K. Campbell, Kansas City, and W. L. Fleisher, New York.

W. A. Brown, Federal Works Agency, Washington, D. C., presented his paper on Air Conditioning Design of New Federal Office Buildings (complete paper to be published in ASHVE JOURNAL SECTION, *Heating, Piping and Air Conditioning*). He described the designs used in some of the existing buildings and explained, in some detail, the system used in the Social Security and Railroad Retirement Board Buildings. Comments on the paper were made by Messrs. L. T. Avery, Cleveland, and C. H. Randolph, Milwaukee.

The interesting subject of Dirt Patterns on Walls by R. A. Nielsen (complete paper published in June 1940 ASHVE JOURNAL SECTION, *Heating, Piping and Air Conditioning*) was presented by the author, who discussed the effects of thermal precipitation and deposits resulting from filtration, electrostatic charges and humidity.

President Giesecke announced that H. H. Erickson would present the discussions on the report of the Committee to Study the Method of Selecting Society Officers and Council Members. The report had been printed and distributed to members in advance of the meeting. Mr. Erickson briefly reviewed the results of the Committee's work and then read written comments on the report from several chapters, among which were, Atlanta, Illinois, Oklahoma, Pittsburgh and St. Louis, and he also read letters from E. K. Campbell, F. C. McIntosh and W. C. Randall.

N. D. Adams, Rochester, Minn., said that the ideas contained in the various letters made it evident that members of chapters were not favorable to the recommendations of the Committee. W. H. Driscoll, New

York, stated that a summary of the comments indicated that the local chapters showed a misconception of the purpose for which the Society was formed. He pointed out that it is a national body rather than a federation of chapters and, unlike the United States of America in which each state must have equal and specific representation, chapters of the Society have no such privilege or function. The business of the Society is conducted at its Annual and Semi-Annual Meetings, and sometimes no chapter representative attends, although in his opinion it would be a fine thing if every chapter could be represented in the work of the Society and its influence felt in national affairs. When the chapters were given a voice in the management of the Society through nominating committee representation, it was evident that their conception of the purpose of the Society and their understanding of the processes of the Society could have created a situation that might be detrimental to its best interest. He believed that the Committee could have recommended a better plan and thought that the special committee which made the study and rendered its report should review the situation and attempt to reconcile the thoughts of the members as a national organization rather than the ideas of the chapters.

C. H. Randolph presented the objections of the Wisconsin Chapter to the Committee's report. E. K. Campbell stated that he had served as chairman of the Nominating Committee and one of the difficulties encountered was the requirement for two meetings which sometimes changed the personnel of the group which met in summer and that which had attended the winter meeting. He suggested that the work of the Nominating Committee be completed at a single meeting. F. J. Pratt, Bremerton, Wash., presented the views of the Pacific Northwest Chapter, which felt that the Committee's suggestion for District *E* involved too large a territory. Prof. L. G. Miller, East Lansing, stated that the Western Michigan Chapter had discussed the Committee's report at length, and felt that the nominating method now in use was satisfactory.

On motion of N. D. Adams, properly seconded, it was proposed that:

> A Committee consisting of H. H. Erickson, chairman, Messrs. R. H. Carpenter, W. A. Russell and three additional members to be appointed by the President of the Society, be requested to review the Committee's report and consider all of the comments submitted and present further recommendations to the Society at the 47th Annual Meeting in Kansas City. The motion was unanimously carried.

SECOND SESSION—

Tuesday, June 18, 10:00 a. m.

President Giesecke called the meeting to order on Tuesday, June 18, and introduced Prof. L. E. Seeley, Yale University, New Haven, who presented his paper on Study of Changes in Temperature and Water Vapor Content of Respired Air in the Nasal Cavity (complete paper published in June 1940 ASHVE Journal Section, *Heating, Piping and Air Conditioning*). This paper created a lengthy discussion and those who participated were Messrs. W. L. Fleisher, Dr. M. B. Ferderber, Pittsburgh, Prof. M. K. Fahnestock, Urbana, and S. R. Lewis, Chicago.

Following this discussion a paper entitled Reactions of 745 Clerks to Summer Air Conditioning by Dr. W. J. McConnell and M. Spiegelman (complete paper published in May 1940 ASHVE Journal Section, *Heating, Piping and Air Conditioning*) was presented by Mr. Spiegelman. Thomas Chester discussed the paper and in a written discussion submitted by A. B. Newton, Minneapolis, he pointed out that the series of tests reported gave a much more accurate knowledge of comfort requirements for long-time occupancy, and further explained that similar tests to take into consideration other periods of occupancy and the season changeover periods were now in order.

A paper on Fever Therapy Locally Induced by Conditioned Air, by Dr. M. B. Ferderber, F. C. Houghten and Carl Gutberlet (complete paper published in May 1940 ASHVE Journal Section, *Heating, Piping and Air Conditioning*) was presented by Dr. Ferderber.

Messages of greeting were received from Allen W. Williams, managing director of *National Warm Air Heating and Air Conditioning Association*, and from Col. W. A. Danielson, former president of the Washington D. C. Chapter and now stationed at the Panama Canal Zone. A personal word of greeting was given by J. C. Fitts, secretary, *Heating, Piping and Air Conditioning Contractors National Association*, and J. F. Collins, Jr., secretary, *National District Heating Association*, brought a message of greeting from the members of his organization.

THIRD SESSION—

Wednesday, June 19, 10:00 a. m.

The first speaker of the third technical session was J. F. Parkinson, who was introduced by President Giesecke. Mr. Parkinson presented his paper on Methods of Rating the Noise from Air Conditioning Equipment (complete paper published in July 1940 ASHVE Journal Section, *Heating, Piping and Air Conditioning*). With W. L. Fleisher, first vice-president, presiding, discussions on this paper were offered by C. M. Ashley, Syracuse, and S. H. Downs, Kalamazoo.

The next paper Air Flow Through Supply and Exhaust Openings in Buildings, by G. L. Tuve and D. K. Wright, Jr. (complete paper published in August 1940 ASHVE Journal Section, *Heating, Piping and Air Conditioning*) was presented by Professor Tuve. Written discussion was submitted by D. W. Nelson, University of Wisconsin, and oral comments were made by C. H. Randolph, S. H. Downs and L. P. Saunders, Lockport, N. Y. Questions brought up in the discussion were answered by co-author D. K. Wright, Jr.

The final paper of the session was given by Prof. A. P. Kratz, one of the authors, on the subject Effect of Room Dimensions on the Performance of Direct Radiators and Convectors, by Professor Kratz, M. K. Fahnestock, E. L. Broderick and S. Sachs (complete paper published in July 1940 ASHVE Journal Section, *Heating, Piping and Air Conditioning*). Those who discussed this paper were J. J. Hayes, and Prof. F. B. Rowley, both of Minneapolis.

President Giesecke introduced C. A. McKinney, president of South Texas Chapter, who invited the members to attend the Fall Meeting of the Society scheduled for

October 14-15 at Houston, Tex., and A. D. Marston, president of the Kansas City Chapter, who extended a cordial invitation to all to attend the 47th Annual Meeting to be held at Kansas City, January 27-29, 1941.

Resolutions

J. F. Collins, Jr., Pittsburgh, chairman of Committee on Resolutions, presented resolutions of approval, which were unanimously adopted on motion of W. R. Rhoton, Cleveland, and W. L. Fleisher.

Whereas, the American Society of Heating and Ventilating Engineers has met in the City of Washington, D. C., for the Semi-Annual Meeting of 1940, and

Whereas, the Washington Chapter of the Society and their ladies have in many ways and at all times shown their gracious hospitality, and

Whereas, the many committees of this Chapter have performed their many functions in an outstanding manner, and

Whereas, the Aerothermal Players, the Kensington Quartet and Stan Brown and his band have presented very fine and unusual entertainment and music, and

Whereas, the Banquet Committee arranged an evening of great pleasure for those who attended,

Whereas, the authors of the many valuable and educational papers have presented these to the benefit of those in attendance,

Whereas, the newspapers and trade press have given this meeting excellent publicity,

Whereas, the Greater National Capitol Committee of the Washington Board of Trade has given excellent cooperation and assistance,

Whereas, the accommodations and service of the Wardman Park Hotel have been unusually satisfactory,

Whereas, the officials and employees of the Federal Bureau of Investigation, the National Bureau of Standards, the Naval Testing Basin and Capitol Heating, Air Conditioning and Power Plants enabled this Society to inspect, in an unusual and very interesting way, the operations of these bureaus and buildings, and finally,

Whereas, the Washington, D. C., Chapter has lived up to its promise of a year ago that we should have cool and delightful weather throughout our visit to Washington,

Therefore be it Resolved, that this Society in meeting assembled express (to these various groups) its wholehearted thanks and sincere appreciation for the many courtesies, services and kindnesses which were enjoyed by all who attended this Semi-Annual Meeting 1940.

Geo. W. Tuttle
John F. Collins, Jr.
Committee on Resolutions

WASHINGTON, D. C.—TEMPERATURES

Hour	*June* 17	*June* 18	*June* 19
8:00 A.M.	70 F	68 F	79 F
9:00 A.M.	70	68	81
10:00 A.M.	70	68	85
11:00 A.M.	70	69	86
12:00 Noon	71	70	77
1:00 P.M.	72	71	78
2:00 P.M.	73	71	85
3:00 P.M.	69	73	87
4:00 P.M.	69	74	87
5:00 P.M.	69	74	87
6:00 P.M.	69	75	87
7:00 P.M.	70	75	84
8:00 P.M.	70	73	81
9:00 P.M.	70	72	80
10:00 P.M.	71	72	78

President Giesecke called for any new or unfinished business, and there being no further business, declared the Semi-Annual Meeting adjourned.

Entertainment

Members and guests who arrived in Washington early on Sunday were greeted by Col. H. H. Downes and 24 enjoyed a day of fishing on Chesapeake Bay. Reports on the number of fish caught have not been classified up to this time.

On Sunday evening Mrs. T. H. Urdahl entertained at her home, the wives of Officers, members of the Council and Committee on Research, and the group included Mmes. Giesecke, Fleisher, Blankin, Collins, Walker, Stacey, Van Alsburg and Geren.

On Monday the Congressional Country Club provided the hazards for 32 golfers who participated in the tournament for the Research Cup and the Eichberg Memorial Cup. J. C. Matchett, Chicago, won the Research tournament and the Illinois Chapter team captured the Eichberg Cup.

Research Cup won by J. C. Matchett—Gross Score 98. Handicap 30—Net 68
Eichberg Cup won by Illinois Chapter—Net Scores by J. C. Matchett 68—C. E. Price 71—R. T. Miller 71
Low Net—J. C. Matchett 98—30, Net 68—golf bag
Low Gross—George F. Miller 75—golf shoes
Second Low Net—J. F. McIntire 100—30, Net 70—putter
Blind Bogey—W. H. Driscoll and D. S. Boyden—Club Covers
Least Putts—M. F. Blankin—25 Putts—golf balls
Most Consecutive Pars—L. F. Kent—3—golf balls
Most Pars on 18 Holes—M. W. Bishop—5—golf balls
Low Net on First Nine—J. W. Kreuttner—31—(non-member)—golf balls
Low Net on Second Nine—L. F. Nordine—31—golf balls
Most 3 on 18 Holes—W. J. Osborn—3—golf balls
Most 4 on 18 Holes—D. B. Tuxhorn—7—golf balls
Highest Gross Score—W. I. Collier—120—cuff links

A group of 60 journeyed to the Laboratories of the National Bureau of Standards and were conducted through the various laboratories by R. S. Dill and others of the staff.

In the morning a group of ladies visited the White House and in the afternoon enjoyed a sightseeing tour of downtown buildings and some visited the Senate Gallery.

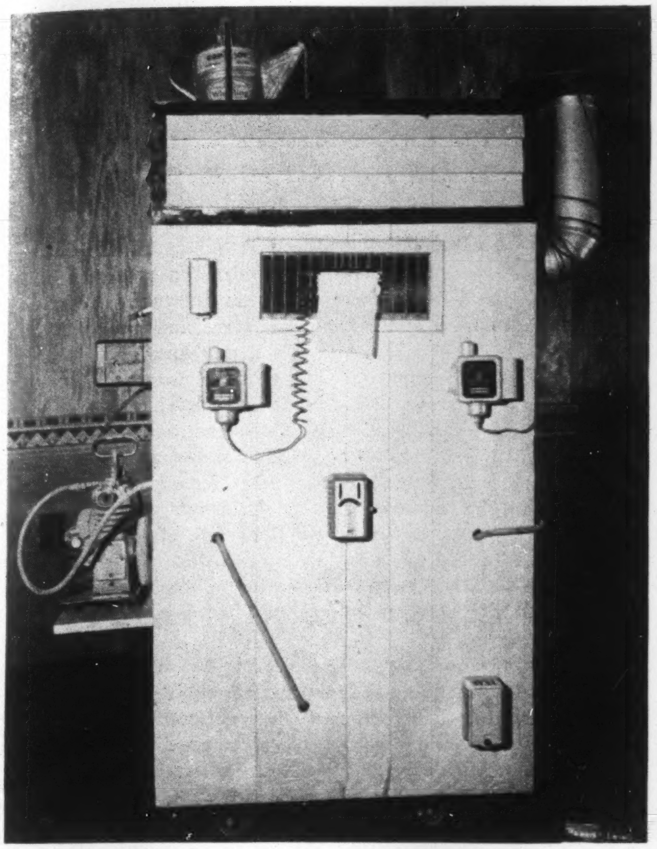
At 9:00 p. m. an informal party and show was held in the Continental Room of the Wardman Park Hotel under the direction of I. M. Day. Dancing was enjoyed after the show and a buffet supper was served.

A group of songs was given by the Kensington Village Singers, including Messrs. Willis Fiske, Lyall Peterson, Paul Johnson and Arthur Applegate.

The *Washington-Round Table* was conducted by I. M. Day and the cast included Clyde Hall, T. H. Urdahl, and E. J. Febrey. *Mis-Information Please* was supplied by Messrs. Febrey, Spurney and Urdahl, in reply to questions asked by Mr. Day.

In the original sketch "Going With the Wind" the cast of Aerothermal players was: F. E. Spurney as "Whett" Butler, Lucille Dixon as "Rosie" O'Hara Butler, F. B. Sale as "Chic" Sale of the Perforated Utilities Co., F. A. Leser as B. G. Blowhard (high pressure salesman from Chicago), and P. H. Loughran, Jr., as Henry Zephr (timid salesman from Timbucktoo). The scene took place on the front porch of "Tarry" Hall, and was sometime between 1865 and the present.

In this sketch a unique piece of apparatus was introduced and space does not permit a complete description.



Super-colossal unit

but it is safe to say that the influence of this unit on Washington temperatures was so great that immediately following the Society's meeting temperatures dropped into the 50's and required the use of fireplaces and heating plants for three days.

In presenting this super-colossal unit, the high pressure salesman explained that it contained a blower and a compressor, and elaborate control features. In pointing out the control devices they appear (from bottom to top) lower right, *coldstat;* center, *comfort-stat;* top, *heat-stat;* left, *not-so-hot-stat;* right, *not-so-cold-stat.* On left side of unit is the *fiddle-stat* which controls the base vibrations of the compressor. The *evaporative sprinkle unit* on top turns water into steam when the machine gets hot, also is useful for putting out fires. The *smoke pipe* on the right is to permit the escape of gases in case the motor or blower burn up, and it is provided with an *animal-stat* to take the bite out of fumes by uniform diffusion. The grille in front is a *perforated utilities,* dual purpose, indicating flow grille which provides accurate information as to the direction and velocity of the wind. The body of the unit is a fibrous product constructed of material which has withstood the test of time. It is produced by Packing, Box, and Caster Co.

On Tuesday morning the ladies visited Arlington, Mount Vernon, Lee Mansion and other points of interest on a motor tour and boat ride on the Potomac River. Many returned to witness the demonstration of the FBI at the Department of Justice Building. In the afternoon a group of ladies enjoyed a card party at the Wardman Park Hotel, and Mrs. Walter Heibel, Old Greenwich, Conn., and Mrs. M. Noble, Syracuse, N. Y., were the winners.

At 7:30 p. m. the Semi-Annual Banquet was held at the Wardman Park with M. T. Firestone acting as toastmaster. D. S. Boyden, past president of the Society presented a memory book to past president J. F. McIntire. A. E. Stacey, Jr., presented the Research Cup and M. W. Bishop, Chicago, presented the Society with a new cup to perpetuate the W. Roy Eichberg Memorial Cup, originally presented by the Philadelphia Chapter. The cup was accepted for the Society by M. F. Blankin, Philadelphia. A brief address was made by Hon. Luther Patrick, representative of the 9th District of the State of Alabama. After dinner dancing was enjoyed until after midnight.

Following the technical session on Wednesday inspection trips were organized to the Naval Testing Basin, Carderock, Md., Central Heating Plant, and the Capitol Power Plant and Air Conditioning Systems.

In advance of the meetings many committees held conferences and the Council decided to hold the Fall Meeting of the Society at Houston, Tex., October 14 and 15, and the 47th Annual Meeting at Kansas City, Mo., January 27-29.

As Mrs. Engineer Saw the Meeting

By Jane Sutton Gregg

BEING wedded to an air conditioning engineer, no one realizes more forcibly than I do the temerity of any mere female who might try to invade the sacred precincts of an engineering organ. I am fully aware of the vast technicalities, the deep theorizing, the practical study and applications bespeaking the background, vital interests and achievements of such a highly trained group of men. Furthermore, I know that to the editorial staff of an engineering publication any terms short of Btu, air flow, heat load, kilowatt hours, etc., are to be decidedly frowned upon as "having no bearing upon the immediate situation." Nevertheless—and I plead my own defense—a great many engineers, yes, even editors have wives or mothers, sisters or sweethearts, womenfolk who are naturally and rightly interested in the business as well as social progress of their men. Doubtless you will grant this point, and yet question the aforementioned invasion. Therefore, to continue my defense: a majority of these womenfolk would also like to take some active part in this progressive pace.

In a field necessarily prohibitive except to those few women who are themselves trained engineers, there would seem little about which a laywoman could write. The conclusion would thus be drawn that Mrs. Engineering Wife would be concerned solely with the social aspects and activities which Mr. Engineer would allow himself individually and as a member of various organizations. Notable among these social amenities are the seasonal gatherings held in different parts of the United States, and known as meetings or conventions.

Having attended several of these meetings, and as a member of the group recently playing host to the Semi-Annual gathering of the ASHVE at Wardman Park Hotel, Washington, D. C., I would now like to speak from the woman's point of view.

First, let me interpolate in all sincerity that it is a distinct privilege to move among such an organization. The standards and ambitions of the men in this class and of their womenfolk tend to elevate their meetings above the allegations usually attached to conventions in general.

While looking back with pleasure on past gatherings, let me, for the sake of brevity and current interest, talk of the meeting just culminated June 16 through June 19 at Washington, D. C.

I believe that most women will agree that half the fun of having a party is the planning of it. Bearing that out, a large portion of my enjoyment was afforded by the preliminary discussions and plans as to what features would give our visitors the most satisfaction. Here, I would like to palm the committeemen for giving primary consideration to those events which would most delight the ladies, and for lending an attentive and unbiased ear to all female suggestions along that line.

Understandably, the Washington Chapter (and I'm sure the guest members) was grateful for the pleasant weather that prevailed during the three days; proving that Washington can be a gracious receptionist upon occasion.

To scan the entertainment events in some detail: Sunday, beginning at 8:30 a.m., was given over to those fishermen who cared to join a party on Chesapeake Bay. Confidentially, I have it on good authority, that when the fish ceased proving tractable —or attractable, as you will—*they* baited the fishermen. In other words, the erstwhile invincibles cast aside rod, reason and rigging and jumped overboard to join the aquatics in their native depths.

Monday at 10:30 in the morning the ladies left the hotel by bus for a trip through 1600 Pennsylvania Ave., otherwise known as the White House. As far as we could ascertain, most of the ladies kept themselves admirably controlled and only minor political bickering was apparent! However, it might amaze you to learn that several of our more venturesome sightseers demanded permission to see the President's bedroom. Whereupon the indignant guide stated that even he had not attained sufficient stature to be allowed to gaze upon that spectacle.

In the afternoon, there was a most informative sightseeing tour of many downtown buildings. This tour included the Capitol, Pan-American Union, Library of Congress, Supreme Court Building, Botanical Gardens, and the Washington Monument. Quite an undertaking this, but all of the ladies were good sports and none fell by the wayside; although, I am confident that many were secretly relieved that climbing the Monument steps was strictly forbidden.

Monday night the assembled guests were swept off their feet by the drama and histrionics of "Going With the Wind," an original playlet written and produced by members of the Washington Chapter. The fact that some of the actors' lines also unintentionally went with the wind only added to the general merriment. Enormously effective and stimulating were the lyrics composed for the occasion by Washington's Fred Leser and set to the music of the *Battle Hymn of the Republic*. This gallant opus was rendered with gusto by the Kensington Singers, and it assuredly deserves to be recorded herein.

BATTLE CRY OF THE A.S.H.V.E.

"We're here to sing the glory
Of the A-S-H-V-E,
How from hot and humid weather
It hath made all mankind free.
Thanks to air conditioning
Can everyone in comfort be.
Its joys are everywhere.

Chorus:
Hail our heating engineers,
Ventilating engineers,
Hail to A.S.H.V.E.
Our works are everywhere."

Dancing was next in order, punctuated by a most appetizing Smorgasbord which included such goodies as sliced chicken and turkey, shrimp salad and crab a la Newburg (the latter hint to make envious those who missed it).

Tuesday morning, the ladies left the hotel at 9:30, again by motor to drive by way of interesting landmarks in Georgetown to Arlington. There we saw the impressive Amphitheatre and the Tomb of the Unknown Soldier. From Arlington we drove through historic Alexandria, with its quaint Christ Church, the old apothecary shop, Gadsby's Tavern and the remarkable Masonic Temple with its commanding view of the countryside. Leaving Alexandria, we drove on to Mt. Vernon via the scenic four lane Memorial Boulevard.

And here let me insert the fact that a vital part of these motor tours, indeed a revivifying influence, was Willie. Willie was the loquacious "pointer-outer" who never missed a point, and who surely must have endeared himself to his audience. Be it said to his credit that he really knew his stuff, and gave out with some unusual facts and anecdotes. Did *you* know, for instance, that George Washington's crowning glory was red; or that Martha weighed over two hundred at her death?

Arriving and "de-bussing" at Mt. Vernon, and after a short course from Willie as to the best way to see the most things in the shortest possible time, we were free for an hour to wander about the lovely grounds, gardens and mansion.

Promptly at 12:25 the new streamliner S.S. Mt. Vernon, pride of the Wilson Line, gave a warning whistle. Collecting ourselves, we went aboard at 12:30 to enjoy a leisurely sail up the Potomac and the contents of the box lunches that were distributed among us.

The buses met our boat at the Washington docks, and drove us to the Federal Bureau of Investigation where those who were well-heeled elected to take the two hour inspection tour. (P.S. A little group of serious card players returned to the hotel for a restful game of bridge.) We were conducted through the F.B.I. in a most businesslike manner, saw weapons and heard of actual experiences terrifying enough to make even the boldest of us quaver. I am certain that we all came away with silent gratitude to Uncle Sam for doing his noble best to rid our happy land of its unsavory elements.

At 7:00 p.m. Tuesday evening, the final plum was pulled from the meeting pie—namely, the Semi-Annual banquet and dance held in the air-conditioned-for-the-event Continental Room of the hotel. In order to further torment the palates of those who could not be "among those present," I will mention that two epicurean attractions were the generous servings of Maryland fried chicken and fresh cherry pie with *chocolate* ice cream atop. This lured a large attendance, and a satisfying representation of notables to grace the head table. Highlights at this time were the speech by the Society's National President, F. E. Giesecke; presentation of the Past President's Memory Book to J. F. McIntire; distribution of the golf trophies, and a timely address by the Honorable Luther Patrick, Representative from Alabama. The remainder of the evening was whirled away in many and varied expressions of the terpsichorean art.

Wednesday morning the ladies were taken downtown to shop or window-shop as conscience might dictate, and after luncheon, general exodus became the program.

Please do not think me boastful or smug; I have not meant to be, but they do say that when a hostess enjoys her own party its success is assured. By that token we Washington members —and I believe I speak for the men as well as for the women —hope that our thorough enjoyment of the whole affair was a key to our guests' reactions.

Therefore, be it herewith attested that at least one Mrs. Engineer gives hearty approval to the manner in which Mr. Engineer conducts his meetings and reports favorably on the social progress of the American Society of Heating and Ventilating Engineers.

Author's note: Lest my readers wonder just where the highly technical engineers were during the frivolity on the part of their ladies, I might add that in nearly all cases they were deep in the redoubtable thrills of "Dirt Patterns on Walls," "Study of Changes in Temperature and Water Vapor Content of Respired Air in the Nasal Cavity," "Air Flow Through Supply and Exhaust Openings in Buildings," etc., etc.

Aerial view showing central business section of downtown Houston

Houston In October

THE Society will hold its Fall Meeting deep in the Southwest, at Houston, Texas, and the South Texas Chapter will be host for the occasion. The Council has selected the dates, October 14 and 15, for this two day session, at which six technical papers will be presented.

Headquarters for the Meeting will be at the Rice Hotel, centrally located in downtown Houston. Registration of members will commence at 8:30 a. m., October 14.

Arrangements for the meeting and the entertainment of visiting members will be directed by C. A. McKinney, *general chairman.* He will be assisted by the following committeemen: J. van O. Weaver, *vice-chairman;* J. A. Walsh, *Publicity;* W. R. Etie, *Transportation;* I. A. Naman, *Tours;* A. M. Chase, Jr., *Banquet;* D. S. Cooper, *Registration;* A. B. Banowsky, *Entertainment;* R. F. Taylor, *Finance;* A. F. Barnes, *Ladies;* G. D. Mayes, *Sports.*

The Council will hold its regular quarterly meeting during the Fall Meeting, which offers an opportunity for a general get-together of members in the Southwest region. The Meetings Committee has planned an attractive technical program which will cover subjects of interest to members, including air conditioning, ventilating and warm air heating and the reports on research projects now being conducted by the Committee on Research.

Members who have not previously visited the Southwest will find Houston a thoroughly modern city with an inspiring record of growth and a colorful history. Houston was established over one hundred years ago, and today has one of the South's great-

RAILROAD FARES

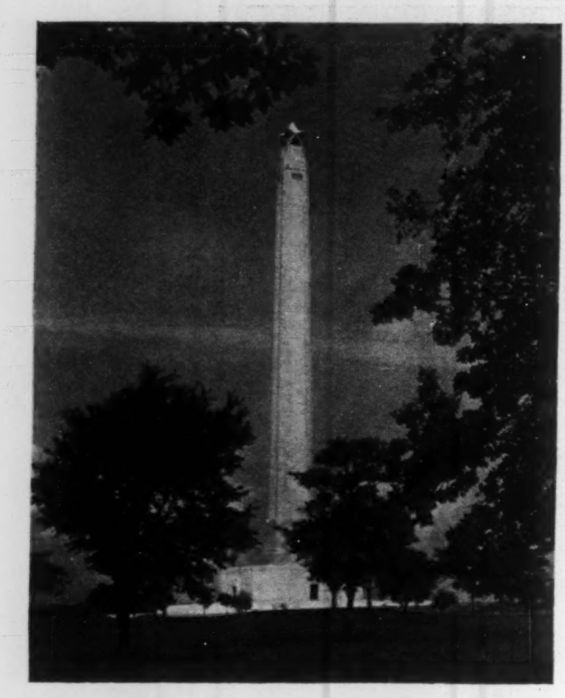
From	Round Trip Railroad	One-Way Lower Berth
Grand Rapids, Mich.	$ 57.90	$11.35
Detroit, Mich.	62.90	12.10
Chicago, Ill.	49.55	8.70
Minneapolis, Minn.	54.80	10.25
Seattle, Wash.	121.70	18.40
San Francisco, Calif.	75.60	13.40
Portland, Ore.	113.45	18.40
Los Angeles, Calif.	75.60	12.60
Kansas City, Mo.	32.75	6.30
Oklahoma City, Okla.	20.20	3.95
Dallas, Tex.	11.00	2.65
New Haven, Conn.	82.65	13.15
New York, N. Y.	78.25	12.60
Philadelphia, Pa.	73.00	12.10
Washington, D. C.	67.30	10.80
Raleigh, N. C.	64.00	9.75
Atlanta, Ga.	40.15	6.30
New Orleans, La.	16.75	2.65
Cincinnati, Ohio	52.30	8.70
Boston, Mass.	95.55	14.20
Montreal, Que.	97.70	13.95
Toronto, Ont.	77.00	11.85
Buffalo, N. Y.	74.35	11.85
Cleveland, Ohio	66.95	10.50
Pittsburgh, Pa.	67.30	10.80
St. Louis, Mo.	36.75	6.85
Winnipeg, Man.	82.95	13.40
Omaha, Nebr.	41.70	7.65
Des Moines, Ia.	43.15	8.70
Milwaukee, Wis.	53.70	9.75

J. A. Walsh
Publicity

C. A. McKinney
General Chairman

J. van O. Weaver
Vice-Chairman

R. F. Taylor
Finance



San Jacinto Memorial Shaft at San Jacinto Battleground

est sky lines, and a population of more than 400,000. The city was named after General Sam Houston and was the second capital of Texas.

For many years Houston has been known as the Oil Capital of the world, as more than half of the oil production of the nation is concentrated within a few hours drive of Houston. There are 185 producing oil fields within 150 miles of the city with a current oil production of 315,000 barrels per day. Although Houston is an inland city, the ships of all nations come directly to its docks and it has become the world's greatest cotton port as a result of the construction of a ship channel in 1916. The city of Houston also has an important place in the live stock industry and each year the Houston Fat Stock Show rivals the other large expositions in Chicago, Kansas City and Fort Worth.

The Rice Hotel

Houston has fine transportation facilities, as good roads connect it with other principal cities of the state. Eighteen railroads and several air lines serve the city, so that it is easily accessible from all parts of the United States. Direct steamship service is available from New York and combination boat and rail transportation can be obtained via New Orleans from East Coast cities. Members who desire may make the trip one-way boat, one-way rail.

Houston has had a colorful history since its incorporation in 1839. A towering monument rising 567 ft marks the site of the old San Jacinto Battle Field. In the spacious base is a museum of Texas history which is of great interest to every visitor.

ASHVE members should plan to go to Houston for the Fall Meeting October 14 and 15. A cordial welcome awaits every member.

Williams Retires from Active Service

Allen W. Williams

Allen W. Williams, after 27 years of service as managing director and treasurer of the *National Warm Air Heating and Air Conditioning Association,* announced his retirement from active service in July. Although his resignation as an officer became effective, he is not severing his connection with the association, as he will continue in an advisory capacity, giving advice and suggestions whenever needed.

In 1914, at the outbreak of the World War, Mr. Williams, along with a number of other well-known men in the heating industry, founded what is now the *National Warm Air Heating and Air Conditioning Association.* He was enthusiastic in forming this group, but was not anxious to be an officer. The founders, however, lost no time in appointing him as a member of the board of directors and as the managing director and treasurer. At that time he did not foresee that it would develop into a nation-wide organization, numbering more than 100 manufacturing members and representing about 85 per cent of production in the field.

Mr. Williams will be succeeded as secretary and treasurer of the *NWAHACA* by George Boeddener, who has been serving the same organization for some time as assistant to the president.

In 1915 Mr. Williams joined the ASHVE and became a Life Member in 1938.

New Officers and Committees for Wisconsin

The following members of the Wisconsin Chapter have been elected to serve for the 1940-41 season:

President—A. S. Krenz
Vice-President—J. A. Cutler
Treasurer—W. A. Ouweneel
Secretary—H. W. Schreiber
Board of Governors—J. H. Volk, E. A. Jones and H. C. Frentzel.
Program—C. H. Randolph, chairman; J. S. Jung and C. S. Becker.
Publicity—P. H. Werner, chairman; Keith Davis and H. C. Frentzel.
Membership—C. W. Miller, chairman; Ernest Szekely and W. A. Ouweneel.

President Giesecke Welcomed at Illinois

April 15, 1940. The April meeting of the Illinois Chapter was called to order by Pres. Tom Brown, with 135 members and guests present to welcome Pres. F. E. Giesecke, College Station, Tex., and the members of the Council who were meeting in Chicago.

Following the reading of the minutes of the previous meeting, President Brown introduced the various officers of the Society, W. L. Fleisher, 1st vice-president, M. F. Blankin, treasurer, A. V. Hutchinson, secretary, and the following Council members: Messrs. Collins, McDonnell, Campbell, Downs, Offner, Tuve, Adams, Kratz and Walker. Three Life Members of the Society from the Illinois Chapter were also in attendance, J. J. Finan, C. F. Newport and John Hale, who is also a past president of the Society. Two other past presidents present were S. R. Lewis and John Howatt.

A. E. Stacey, Jr., chairman of the Society's Research Committee, spoke briefly about the research work of the Society.

John Howatt then introduced President Giesecke, whose subject was Radiant Heating and Cooling. President Giesecke, who for many years was Director of the Engineering Experiment Station at Texas A. & M. College, opened his remarks with a resumé of the theory of radiant heating and the history of its developments. He described early installations and went on with recent research investigations in this country and in Europe on radiant heating where the heating elements or panels are imbedded in the floors, walls, or ceilings of the room.

President Giesecke also described in detail, and illustrated by slides, the construction and reinforcing effect of pipe coils imbedded in concrete construction as well as other interesting phenomena resulting from the application of concealed heating elements. He closed his talk with pictures and brief references to typical installations now in operation and predicted the eventual widespread use of both radiant heat and radiant cooling in buildings.

A lively discussion followed in which Messrs. Hattis, Ryerson, Brooke, Lewis and Aeberly took part.

The meeting adjourned at 10:00 p.m., everyone conceding that it had been one of the best meetings of the year.

New Officers Installed at St. Louis

May 7, 1940. The regular monthly meeting of the St. Louis Chapter was held at the Kingsway Hotel, with 29 members and guests in attendance. In the absence of Secretary Boester, the minutes of the April meeting were read by L. J. DuBois, and were approved as read.

Mr. DuBois read a communication from the Chesapeake & Ohio Railroad quoting special rates to Washington, D. C., for the Summer Meeting, and then read a portion of a letter written by Pres. R. J. Tenkonohy, in which he set forth the St. Louis Chapter's objections to the proposed method of selecting the Nominating Committee for Society officers.

The annual reports of officers and committees were then read. President Tenkonohy presented his report, followed by the report of the treasurer, which was in reality a report for the past two years as there was no audit of the books last year. Paul Sodemann reported for the auditing committee stating that the treasurer's books were found in good order and balancing properly. W. J. Oonk gave the report of the membership committee, which was followed by the report of the attendance committee, given by J. H. Carter.

President Tenkonohy then announced that the chapter was ready to vote for officers for the ensuing year, and appointed Messrs. Szombathy, Driemeyer and Hamig as tellers. The tellers reported the following elected to serve for the 1940-41 season:

President—C. E. Hartwein
First Vice-President—D. J. Fagin
Second Vice-President—M. F. Carlock
Secretary—C. F. Boester
Treasurer—J. H. Carter
Board of Governors—R. J. Tenkonohy, W. J. Oonk, B. C. Simons and L. J. DuBois.

L. Walter Moon, past president of the chapter, took the chair for the installation of the new officers. Installation ceremonies were carried out with the assistance of other former presidents of the chapter, with suitable talks and introductions.

Retiring President Tenkonohy then presented the St. Louis Chapter with a new gavel having a silver name plate, hand embossed by him, and a rising vote of thanks was extended to Mr. Tenkonohy.

Following a short recess, Ralf Toensfeldt, consulting engineer, gave an interesting talk on the subject, The Economics Underlying the Installation of Air Conditioning in Office Buildings, which was well received, as reported by the secretary. The meeting was adjourned at 9:45 p.m.

Southern California Installs Officers

June 18, 1940. The June meeting of the Southern California Chapter was held following a dinner at Steven's Nik-a-Bob restaurant, Los Angeles, with Pres. J. F. Park presiding. After the business session was completed there was a discussion of various methods and new developments of cooling. E. L. Cawby talked on the mechanical cooling phase, followed by James Hill who discussed natural gas for cooling. Leo Hungerford selected evaporative cooling as his subject and E. L. Nelson talked on ice cooling.

The installation of officers followed, and the following were installed as the officers to serve for 1940-41 season:

President—H. H. Douglas
Vice-President—A. J. Hess
Secretary—H. H. Bullock
Treasurer—W. O. Stewart
Board of Governors—O. W. Ott, J. B. Griffith, J. Frank Park and Maron Kennedy.

After the meeting the Union Ice Co. presented a film entitled Treasure Island, which was enjoyed by the members and guests.

Western New York Holds Annual Meeting

May 13, 1940. The annual meeting of the Western New York Chapter was held at the Iroquois Gas Corp., Buffalo, where 50 members and guests were present at dinner preceding the meeting. The minutes of the March and April meetings were regularly read and approved as read.

Pres. L. P. Saunders appointed William Kirkpatrick, John Owen and Herman Seelbach, Jr., as tellers to count the votes cast for the officers and Board of Governors for 1940-41, with the following results:

President—C. A. Gifford
First Vice-President—W. R. Heath
Second Vice-President—H. C. Schafer
Treasurer—B. C. Candee
Secretary—S. M. Quackenbush
Board of Governors—M. C. Beman, Joseph Davis, Roswell Farnham, D. J. Mahoney and L. P. Saunders.

Mr. Candee presented the treasurer's report for the fiscal year, which was followed by the report of the auditing committee, stating that the records of the treasurer were in good order and the amount as reported was correct.

The retiring president thanked the officers and members of the Board of Governors for their splendid support during his year as president.

Mr. Beman announced the plans for the Summer Meeting of the Society in Washington, D. C., and urged every member to attend.

It was then decided to hold a golf meet jointly with the Air Conditioning Council of Buffalo, at the Stafford Country Club, June 7.

Mr. Saunders turned the meeting over to President-elect Gifford and the newly elected officers. Mr. Davis presented the past president's certificate to the retiring president, and in accepting the certificate, Mr. Saunders again expressed his appreciation for the cooperation and support the officers and members gave him during his term of office.

Howard L. Volgenau, assistant secretary of the Buffalo Chamber of Commerce, the guest speaker, was introduced by President Gifford. Mr. Volgenau gave a very interesting talk on the building industry of the Niagara frontier, which was followed by an open discussion. A rising vote of thanks was given the speaker and the meeting was adjourned, according to the report of S. M. Quackenbush, secretary.

Philadelphia Introduces New Officers

May 9, 1940. The regular meeting of the Philadelphia Chapter was held at the Huntingdon Valley Country Club.

After an afternoon of golf and outdoor activities, dinner was served to 79 members and guests, followed by a short business meeting which was called to order by Pres. R. F. Hunger. The reading of the minutes and the treasurer's report were omitted.

A vote of thanks was tendered to Messrs. H. C. Howard and W. A. Smith, whose courtesy made possible the use of the Club for the meeting, after which the newly elected officers were introduced as follows:

President—C. B. Eastman
First Vice-President—H. B. Hedges
Second Vice-President—H. H. Mather
Treasurer—Edwin Elliot
Secretary—A. C. Caldwell
Board of Governors—R. F. Hunger and L. E. Moody.

The meeting was then turned over to the newly elected president, who called on W. P. Culbert to take charge of the awarding of the various golf prizes which had been donated by members of the Society. A. V. Hutchinson, secretary of the Society, was among the many who attended. The meeting adjourned at 9:30 p.m.

Michigan Holds Annual Meeting

May 21, 1940. The annual golf meeting and election of officers was held at the Birmingham Golf Club, with 28 playing golf and 45 attending the dinner and evening meeting.

The meeting was called to order at 8:30 p. m. by Pres. W. C. Randall, and after roll call the reports of the secretary and treasurer were read and approved. President Randall gave a short resumé of the meetings during the year and thanked the officers and committeemen for their assistance and cooperation during his term of office.

President Randall then called upon the chairman of the nominating committee who presented the names of the 1940-41 officers. Following a series of motions, properly seconded and carried, the following were elected to serve the chapter for the coming season:

President—G. H. Tuttle
Vice-President—J. S. Kilner
Secretary—W. H. Old
Treasurer—F. R. Bishop
Board of Governors—W. C. Randall, E. R. Harrigan, S. S. Sanford and M. B. Shea.

R. K. Milward, chairman of the prize committee, complimented Messrs. Akers, Lance and Shea for attendance at the meetings during the year, as well as A. E. Fisher, who attended as guest.

Kickers' handicap awards were given Messrs. Shurger, Partlan, Pinkerton, Kilner, Beattie, Old, Randall, Rowell, Tuttle, Volker, Harrigan, Bishop, Gardiner, Kincaide, Sherzer, Conover, Marzold and Sheley.

A rising vote of thanks was extended to E. D. Sheley who acted as host on this occasion. President Randall then turned the meeting over to the incoming president, G. H. Tuttle, who introduced the newly elected officers and Board of Governors.

E. M. Harrigan presented a past president's certificate, signed by the officers and Board of Governors, to the retiring president, W. C. Randall.

President Tuttle introduced Prof. A. F. Sherzer, University of Michigan, who showed several reels of colored movies taken on one of his recent trips into the Hudson Bay district, and according to the report by Secretary Old the meeting adjourned at 11:25 p. m.

South Texas Chapter Reports on Year's Progress

May 31, 1940. At the May meeting of the South Texas Chapter the following officers for the coming year were elected:

President—A. J. Rummel
Vice-President—D. S. Cooper
Secretary—R. M. Spencer
Treasurer—W. E. Long
Board of Governors—C. A. McKinney, A. F. Barnes and R. F. Taylor.

At this meeting the retiring president presented his annual report in which he reviewed briefly the progress of the South Texas Chapter during the year. He pointed out that the May meeting marked the end of the second fiscal year since the organization of the Chapter, the by-laws for which were adopted May 13, 1938.

President McKinney also stated that, including the May meeting, there were eight regular meetings and one special meeting held during the season. The special meeting was held in College Station on August 19, 1939, during the first Air Conditioning Short Course. At this meeting John Howatt, past president of the Society and chief engineer, Board of Education, Chicago, was the principal speaker.

Six of the regular meetings were held in Houston and two in San Antonio. At the suggestion of Dr. F. E. Giesecke, College Station was omitted from the regular meeting locations since comparatively few Society members reside there.

President McKinney, in his report, briefly outlined the meetings of the past year as follows:

The first meeting of the season was held October 20, 1939, at Houston, and D. S. Cooper spoke on the feasibility and advisability of codes from the engineer's standpoint. M. T. Halbouty also spoke on the Houston Engineer's Club approach to county water problems.

At the November 17, 1939, meeting, also at Houston, W. H. Badgett reported on the Fall Meeting of the Society at Atlanta, and gave a summary of the work on attic fans being carried on at the A. & M. College of Texas. Prof. E. G. Smith addressed the meeting on heat absorption by walls of buildings at the A. & M. College of Texas. A. F. Barnes selected as his subject, the ASHVE and what it means to its members.

The necessity for the revision of city building codes due to air conditioning installations was the topic at the December 15 meeting held in San Antonio, and was presented by B. K. Wyatt.

The first of the 1940 meetings was held in Houston on January 19 and A. E. Vroome, New York, delivered an interesting talk on air conditioning development to take advantage of lowest demand on utility systems.

Dr. M. B. Ferderber, Pittsburgh, was the guest speaker at the February 9 meeting, also held at Houston. Dr. Ferderber spoke on the practical application of air conditioning in the field of medicine.

The next meeting was held in San Antonio on March 25 and had as its guest Prof. E. O. Eastwood, Seattle, second vice-president of the Society, who discussed the status of the heating and ventilating engineer and his future.

Storage refrigeration as applied to air conditioning was discussed by Carl F. Boester at the April 19 meeting, held in Houston.

Following this report on the various meetings held during the year R. M. Spencer submitted the annual treasurer's report, and D. S. Cooper reported on the Society's Annual Meeting in Cleveland.

President McKinney further explained in his report that on May 13, 1939, there were 42 members of the South Texas Chapter, and it is gratifying to report that to date there are 55 members, which shows an increase of 30 per cent during the past year. This clearly shows that the interest displayed by those directly associated with the air conditioning industry is furthering the cause of the Society. He then referred to the statement made by the Society's Membership Committee, "We do not want Joiners in the ASHVE, but we do want members who are interested in and will be active in carrying on the work of the Society."

President McKinney mentioned that the South Texas Chapter was proud of the fact that one of its members is now president of the Society, Dr. F. E. Giesecke, College Station, Tex.

It was with pleasure, President McKinney stated, that he referred to the next Fall Meeting of the Society to be held in Houston, which was scheduled during his tenure in office. He told of the splendid cooperation and assistance given by the Houston Chamber of Commerce, and of the splendid manner in which it prepared the portion of the invitation that went with the formal invitation which had a great deal to do with the success of the Chapter's efforts. Much credit is also given to President Giesecke who did his part in making it possible for the South Texas Chapter to act as host for the Fall Meeting. There is considerable work and planning ahead in arranging for this meeting in Houston, and it is the wish of the South Texas Chapter to make this meeting an outstanding success, and it is expected that each and every member will give his entire cooperation in making it such.

In closing his report, President McKinney expressed his sincere appreciation for the fine cooperation he received from the Chapter officers and members, with whom his association has been most pleasant and enjoyable. He further stated that he considered it a great honor and a trust to have served as president and to continue to serve as a member of the ASHVE, for the Society is composed of men who believe that they can best serve humanity and make this a better world through organized efforts.

Manitoba Host to President Giesecke

April 5, 1940. A dinner meeting of the Manitoba Chapter was held at the Fort Garry Hotel, Winnipeg, with Vice-Pres. P. L. Charles presiding in the absence of Pres. G. C. Davis. There were 17 members and guests in attendance when the minutes of the March meeting were read and approved.

D. F. Michie, chairman of the nominating committee, submitted the following nominations: *President*—P. L. Charles; *Vice-President*—R. L. Kent; *Secretary-Treasurer*—Ivan McDonald; *Board of Governors*—G. C. Davis, F. L. Chester and E. F. Munn.

The chairman appointed a committee of two, D. F. Michie and William Glass, to audit the chapter books previous to the May annual meeting.

Vice-President Charles expressed his regret that, due to an accident, President Davis could not attend the meeting, and it was decided to send a telegram to him from the chapter.

The guest speaker of the evening, F. E. Giesecke, president of the Society and professor emeritus at the Texas A. & M. College, College Station, Tex., was then introduced. President Giesecke gave a most interesting talk, illustrated by slides, on the subject of radiant heating and cooling. William Worton expressed his appreciation to President Giesecke on behalf of the chapter for his excellent presentation. The meeting was adjourned at 10:00 p.m.

Harold J. Spielmann Dies Suddenly

Harold J. Spielmann died suddenly June 16 at his home, 507 Elmore Ave., Park Ridge, at the age of 40. Born in Chicago he moved to Park Ridge in 1918 and was graduated from the University of Wisconsin in 1922.

Mr. Spielmann was one of the pioneers in the air conditioning industry and was chief engineer of the Vilter Mfg. Co. of Milwaukee. He joined the ASHVE in 1933 and took an active part in its activities, and will be missed by his many friends and associates in the Society. He was also a member of the Park Ridge Board of Education.

He is survived by his widow, two children, Kathryn, 10, and Peter, 2; his mother, two brothers and one sister, to whom the Officers and Council of the Society extend their sincere and heartfelt sympathy. Funeral services were held from his home and burial was in Town of Maine Cemetery, Park Ridge.

Life Member
J. J. Finan
Dies in Chicago

James J. Finan, a Life Member of the Society, died at his home, 7214 Merrill Ave., Chicago, on Sunday, July 14, at the age of 75. Born in Bradford, England, in 1865, he received his education in the common schools, specializing in physics.

In 1887 he became assistant engineer at the 68th St. Pumping Station, Chicago, and later became the operating and supervising engineer for the University of Chicago. In 1903 he went with the Board of Education, City of Chicago, as operating engineer, and in 1906 he was appointed supervising engineer, which position he held until 1936, when he retired from active business.

Mr. Finan was supervising engineer in charge of the construction of numerous buildings, such as the Hyde Park High School, Englewood Heights School, Curtis Heights School and approximately 35 elementary schools in Chicago. In this connection he supervised the installation of heating and ventilating apparatus, and the plumbing and electrical wiring.

He was beloved by his many friends and associates in the Society, and he will be greatly missed by his fellow members of the Illinois Chapter.

Mr. Finan is survived by his widow, Anna, a daughter, Agnes, and a son, Edward, to whom the Officers and Council of the ASHVE extend their sincere sympathies in their sorrow.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 10 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge the members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by August 15, 1940, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
BADHE, J. M., Asst. Engr., Volkart Bros., Bombay, India.	J. A. E. Heard R. V. D. Dunne	H. S. Traynor W. P. Henszey
KEELING, FRED V., Asst. to Maintenance Supt., Public Works Div., Philadelphia Navy Yard, Philadelphia, Pa.	F. B. Millham H. G. McCullough	C. F. Dietz H. H. Erickson

REFERENCES	CANDIDATES	
	Proposers	*Seconders*
Lyon, Douglas McC., Mfrs. Sales Repr., Syracuse, N. Y.	W. H. Driscoll N. E. Sheldon	W. D. Graham R. E. Cherne
Nolan, Ralph E., Mfrs. Repr., Atlanta, Ga. (*Advancement*)	T. T. Tucker W. J. McKinney	C. B. Cole C. L. Templin
Orgelman, G. H., Student, Yale University, New Haven, Conn.	L. E. Seeley E. J. Rodee	L. A. Teasdale M. F. Smith (*Non-Member*)
Pfeiffer, David C., Power Sales Engr., Dallas Power & Light Co., Dallas, Tex.	M. L. Brown S. H. Green	R. B. Taylor T. H. Anspacher
Sachs, Sam, Research Asst. in Mech. Engrg., University of Illinois, Urbana, Ill.	A. P. Kratz M. K. Fahnestock	A. E. Hershey R. B. Engdahl
Salzer, A. R., Jr., Engr., F. H. Chisholm, New Orleans, La.	L. V. Cressy John Devlin	J. J. Friedler, Jr. H. J. Kelly
Stein, Jerome, Student, Yale University, New Haven, Conn.	L. E. Seeley E. J. Rodee	L. A. Teasdale M. F. Smith (*Non-Member*)
Sutch, Harry C., Htg. Engr., Montgomery Ward, Chicago, Ill.	E. M. Mittendorff F. J. Wilkinson	A. O. May J. F. Brocha

CANDIDATES ELECTED

In the past issues of the Journal of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

Ambrose, Eugene R., Air Cond. Engr., American Gas & Elec. Service Corp., New York, N. Y.

Bartlett, Amos C., B. F. Sturtevant Co., Hyde Park, Mass. (*Reinstatement*)

Beckwith, F. J., Htg. Engr., Crane Co., Jacksonville, Fla.

Burns, Frank G., New Orleans Public Service, Inc., New Orleans, La. (*Advancement*)

Goodman, C. E., Mgr., Trane Co. of Canada Ltd., Halifax, N. S.

Hyde, L. L., Gen. Mgr., Grudem Co., St. Paul, Minn. (*Reinstatement*)

Mally, Chester F., Cons. Engr., Detroit, Mich. (*Advancement*)

McCrea, Lester W., Mfrs. Repr., Baltimore, Md. (*Reinstatement*)

Minkler, William A., Asst. Sales Mgr., Young Radiator Co., Racine, Wis.

Moffat, Ormond G., Application Engr., Canadian Westinghouse Co., Ltd., Hamilton, Ont., Can. (*Advancement*)

Noble, Milner, Chief Engr., Aerofin Corp., Syracuse, N. Y. (*Reinstatement*)

Randolph, Harold F., Vice-Pres., International Heater Co., Utica, N. Y.

Ryan, Harold J., Pres., Harold J. Ryan, Inc., New York, N. Y.

Sampson, Will D., Cons. Engr., St. Louis, Mo.

Shell, Jack, Chief Engr., Air Cond. Dept., Jefferson Amusement Co., Beaumont, Tex.

Toensfeldt, Ralf, Consulting Engr., St. Louis, Mo.

ASSOCIATES

Bailey, J. L., Asst. Chief Engr., Parks-Cramer Co., Charlotte, N. C. (*Reinstatement*)

Baker, Donald L., Sales Engr., Messrs. Martin & Co., Delhi, India

Belford, Louis duB., Div. Supervisor, Minneapolis-Honeywell Reg. Co., Philadelphia, Pa.

Cottrell, W. H., Gen. Mgr., Home Owners Htg. Equip. Co., Minneapolis, Minn.

Duplant, Jean L., Westinghouse Elec. Co. of India, Bombay, India. (*Reinstatement*)

Hall, Truman, Stoker Sales & Service, Dygert Dist. Co., Grand Rapids, Mich.

Killian, William J., Sales Repr., Herman Nelson Corp., Cincinnati, O.

King, John S., Htg. Contractor, Brooklyn, N. Y.

Klein, Fred R., Asst. Mgr. Htg. Dept., Globe Machy. & Supply Co., Des Moines, Ia.

Kreiner, Jack, Plbg. and Htg. Contractor, New York, N. Y.

Labonne, Henri, Mgr., Htg. Div., Codère Ltd., Sherbrooke, Que., Can.

Lawrence, Chester T., Br. Mgr., U. S. Radiator Corp., Minneapolis, Minn.

Mergardt, Albert P., Pres. & Mgr., American Htg. Engrg. Co., Inc., Washington, D. C.

Murphy, Daniel C., Sales Repr., D. C. Murphy Co., Des Moines, Ia.

Platz, John F., Sales Engr. & Mgr., J. M. & L. A. Osborn Co., Cleveland, O.

Roper, Richard F., Pres., Pleasantaire Corp., Washington, D. C.

Stevens, Earl K., Treas., International Exposition Co., New York, N. Y.

Stuart, W. W., W. W. Stuart Co., Des Moines, Ia.

Tiernan, James P., Engrg. Dept., Tru Way Sheet Metal Fabricators, E. Orange, N. J.

Virrill, George A., Chief Engr., The University Club, New York, N. Y.

Webster, Chester C., Pres., John Hankin & Bro., New York, N. Y.

JUNIORS

Anoff, Seymour M., Engrg. Dir., DeVry & Co., Chicago, Ill.

Beals, Dowell E., Supervising Engr. & Estimator, M. F. Fischer & Son, Norman, Okla.

Brown, H. Junius, Meadville, Pa.

Duitch, Paul R., Sales Engr., Delavan Engrg. Co., Des Moines, Ia.

Ellis, George W., Engr., Acme Htg. & Vtg. Co., Chicago, Ill.

Satterlee, Harry A., Partner, The Schulte Plbg. & Htg. Co., Joplin, Mo.

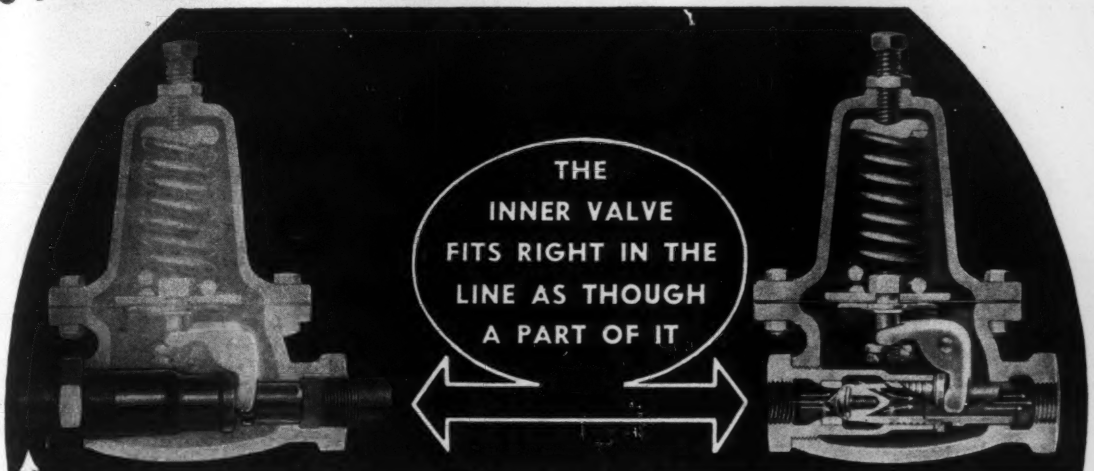
Skinner, Alton, Jr., Htg. & Air Cond. Engr., Bagwell Plbg. & Htg. Co., Durham, N. C.

STUDENTS

Cooperman, Edward, Student Carnegie Inst. of Tech., Pittsburgh, Pa.

Gjertsen, George, Student, Technicians Inst., New York, N. Y.

STRAIGHT LINE FLOW ALL THE WAY


THE INNER VALVE FITS RIGHT IN THE LINE AS THOUGH A PART OF IT

NOTE: What might be mistaken for a pipe running through the phantom Streamlined Valve above is really the housing which contains the inner valve. Through it, you have the Straightline Flow that brings such enthusiastic comments as voiced by Case No. 257 and Case No. 167 which you can read in this advertisement.

READ THIS CASE NO. 257 WITH REFERENCE TO

CASH STANDARD *Streamlined* TYPE 1000 PRESSURE REDUCING VALVE

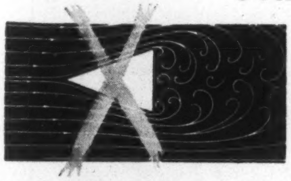
"If all your CASH STANDARD VALVES are like your '1000's' you will be replacing the other regulators we have in this plant and then you will be through for a long time. We don't have any replacements to make on your Streamliners nor any maintenance costs either."

Bought More Than 125 Streamliners in 3 Years — Because of Accuracy, Capacity, and No Troubles

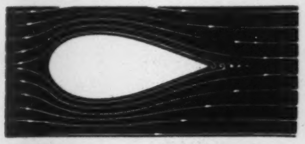
"We have more than 125 of your 1000 Streamlined Valves in operation so we should know what we are talking about when we say we are absolutely sure of their accuracy, capacity, and freedom from trouble. After three years' experience with them we have found these Valves so good that we are making all replacements with them on steam, water, air, and gas."

Case No. 167

ILLUSTRATIONS DIRECTLY BELOW SHOW YOU THE DIFFERENCE STRAIGHT LINE FLOW MAKES . . .



The valve increases performance results by eliminating ordinary valve turbulence as indicated in illustration to left. There is no detour around a dividing wall — the direction of flow is not changed at right angles because of a seat wall — also, the flow is not broken up by valve stems, springs, or other parts.



You get Streamlined flow as indicated in illustration to right. And because of this Streamlined flow and no turbulence, you are easily able to meet peak demand and yet hold the reduced pressure constant at the same time. You experience no spoilage results due to erratic pressure — because the reduced pressure never varies.

See Charts in BULLETIN 1000

Steam, air, water capacity charts for all Streamlined Type 1000 Valves are shown in Bulletin 1000. These charts are easy to use — they enable you to determine precisely how much fluid any size Streamlined Valve will deliver under your exact pressure conditions—for steam, air, (and other gases), water (and other liquids).

Send for BULLETIN 1000

You may select a CASH STANDARD Streamlined Valve exactly suited for your service conditions. Bulletin 1000 shows how. Any combination of metals can be obtained for body, trim, valve seat, and seat ring. Handwheels for quick pressure adjustment also available.

Free TRIAL

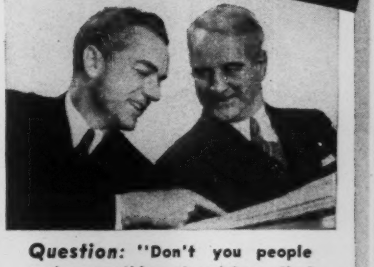
Try this Valve in your plant. No red tape. Just say "Ship on 30 days' free trial." After 30 days we send you a bill. You pay it or you return the Valve at our expense. No strings attached. You are the sole judge. Why not order one Valve on trial — today?

DEFINITELY NEW
Streamlined
A. W. CASH COMPANY

A. W. CASH COMPANY
DECATUR, ILLINOIS

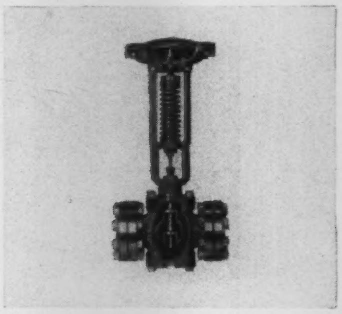
CASH STANDARD
CONTROLS . . VALVES

A CASH STANDARD "GET ACQUAINTED" COLUMN



Question: "Don't you people make anything besides that Streamlined Valve you talk about so much?"

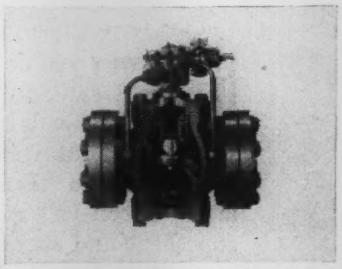
Answer: "Yes Sir; we do! And we propose to picture one or two of them here each time."



Cash Standard Type 34 Pressure Reducing Valve. For practically all fluids. Sizes: ½" to 12" inclusive. Highest initial pressure 800 lbs.; reduced pressure, vacuum to 150 lbs.

The best that money can buy in this type valve. Precision built; every mechanical detail right as can be. Long time service. Has roller guides, roller bearing — no lost motion; a change in the pressure under control produces corrective valve movement.

Bodies: iron, bronze, steel. Trims: iron, bronze, stainless steel, monel metal. Ends: screwed, flanged, ammonia type, welding type.



Cash Standard Type 10 Pressure Reducing and Regulating Valve — self-contained, pilot operated. For holding reduced pressure within extremely close limits.

Sizes: 2" to 12" inclusive. Highest initial pressure 600 lbs.; highest reduced pressure 250 lbs. For use with water, air, Freon, ammonia; or with any non-corrosive gas or oil. Valve operating fluid not wasted; it discharges to outlet pipe.

Bodies: iron, bronze, steel. Trims: iron, bronze, stainless steel, or monel metal. Ends: screwed, flanged, ammonia type.

A dial on the pilot valve makes it easy to widen or narrow the control pressure range until you establish the ideal range for your service.

Get Free Bulletins on Above . . . Write to
A. W. CASH COMPANY
DECATUR, ILL.

WHAT'S THIS? NO WATER JACKET ON THE CYLINDERS?
THAT'S RIGHT!... YOU CAN DO WITHOUT IT BY USING FREON* REFRIGERANTS!

HERE'S WHY you do not need an expensive water jacket on cylinders and cylinder heads of your compressors to cool the refrigerant gas . . . when you use "Freon-12" refrigerant! "Freon-12" gas develops low superheat and stays well below carbonization temperature of mineral lubricating oil. Its temperature as a compressed gas through the discharge valve, under standard ton conditions, is only 109.5°F. So, naturally, "Freon-12" does not need water jacket cooling!

What this means to you!

By eliminating water jackets you cut the cost of patterns, castings, foundry labor and scrap, machine work, and assembly. You save by ending the need for water connections, gaskets and other fittings and equipment for the circulation of water through the cored water passages. In addition, you reduce the cost of installation, maintenance, and service. The use of uncored but finned cylinders and cylinder heads for "Freon-12" charged compressors also reduces the possibility of refrigerant leaks from the system, or of water entering the system through thin wall iron castings.

Uncored cylinders for "Freon-12" compressors operate at low temperatures and pressures. They are small in size, light in weight, simple in construction, efficient in operation! They give you low first and maintenance cost and long years of efficient service.

What else do you get with FREON?

▶ Featured on this page is just *one* of the outstanding advantages you get when you specify "Freon" refrigerants! There are many others. For instance, "Freon" refrigerants are safe. And this harmlessness makes possible still another advantage: "Freon" refrigerants permit use of the newer, more efficient direct expansion system in place of the old-fashioned indirect system, using brine coils.

KINETIC

FREON

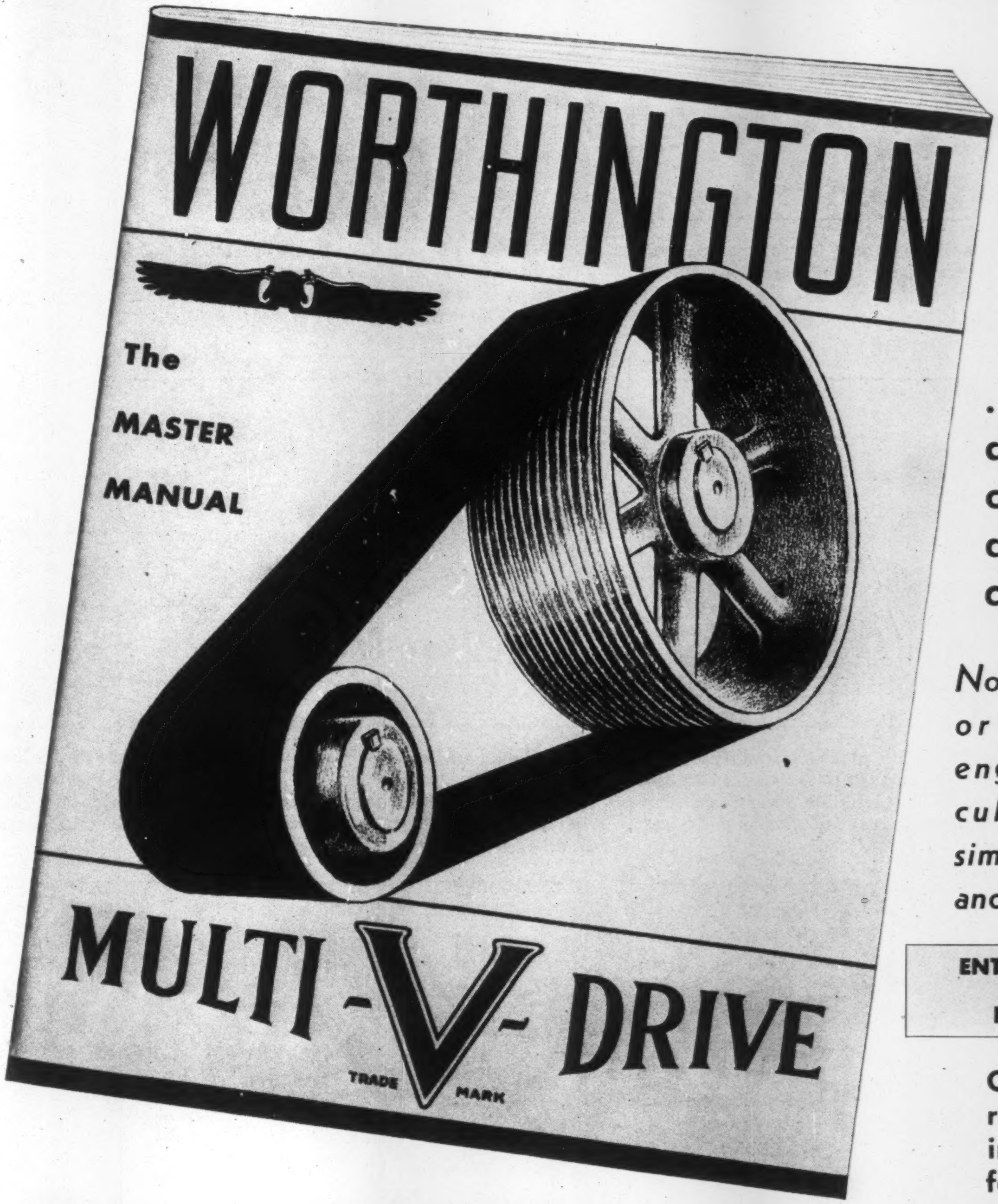
REG. U. S. PAT. OFF.

safe refrigerants

**"Freon" is Kinetic's registered trademark for its fluorine refrigerants*

KINETIC CHEMICALS, INC., TENTH & MARKET STREETS, WILMINGTON, DELAWARE

This **MASTER MANUAL**
takes the mystery out of V-belt drive selection



In three minutes

. . . . you can determine the correct belt and sheave combination.

No tricky figuring or complicated engineering calculations . . . just simple arithmetic and common sense.

ENTHUSIASTICALLY APPROVED EVERYWHERE

Over 10,000 requested in less than four months.

And a copy is yours for the asking.
Write or use the coupon below. NOW, BEFORE YOU TURN THE PAGE.

WORTHINGTON PUMP AND MACHINERY CORPORATION
Harrison, New Jersey
Send me a copy of the Worthington Multi-V-Drive Master Engineering Manual, V-1400-E2.

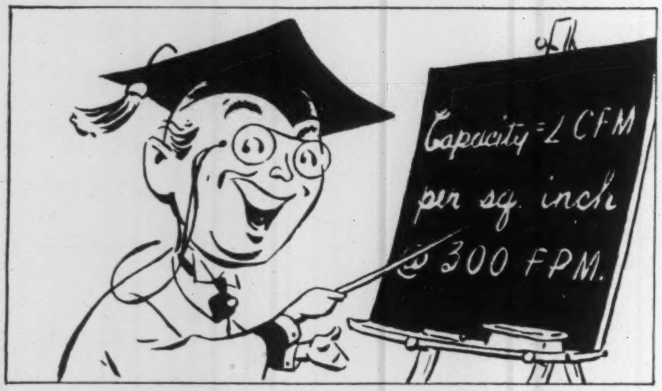
Name__________ Position__________
Firm__________
Address__________

MVO-1A

Reading time: 58 seconds. And worth it!

1 **The treasurer's** praises will be music to your ears, when you change to Dust-Stop* Air Filters in your air-conditioning installation. Cost: Approximately 1-cent per CFM to install, including frames; about 1/10th-cent per CFM, when filters need changing.

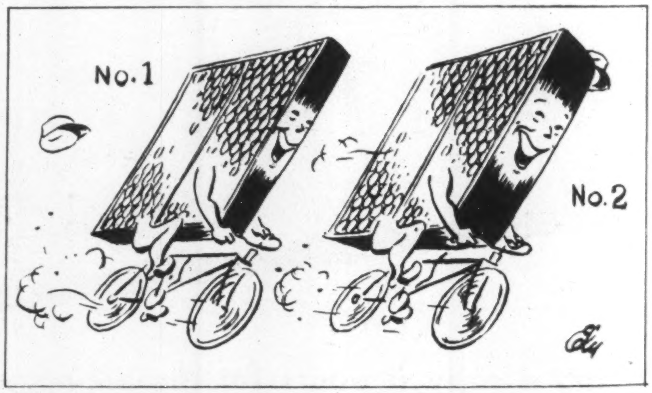
2 **You couldn't be** safer with an old maid than you are with Dust-Stops. The all-glass filtering medium is Fiberglas.* It is coated with a patented adhesive. Neither will support combustion. The old maid won't either.



3 **Look at these** efficiency equations, please. Capacity: 2 CFM per square inch of area at 300 FPM. Resistance: (in inches of water gauge per inch of depth) .045 to .050 clean, and .11 to .12 dirty. These filters stop virtually all "nuisance" dusts, including most hay fever pollen.

4 **Changing a five** dollar bill couldn't be easier, or require less skilled labor, than changing Dust-Stops. This replaceable filter eliminates cleaning, recharging, draining, expert supervision and the need to keep a supply of spares. Dust-Stops fit all types of air handling systems.

5 **Does a turnip** bleed? Neither do Dust-Stops! The dust-catching adhesive on these filters will not deposit tiny droplets in the ducts or on the walls. Naturally, a fire-hazard from the adhesive in the duct system just doesn't exist.



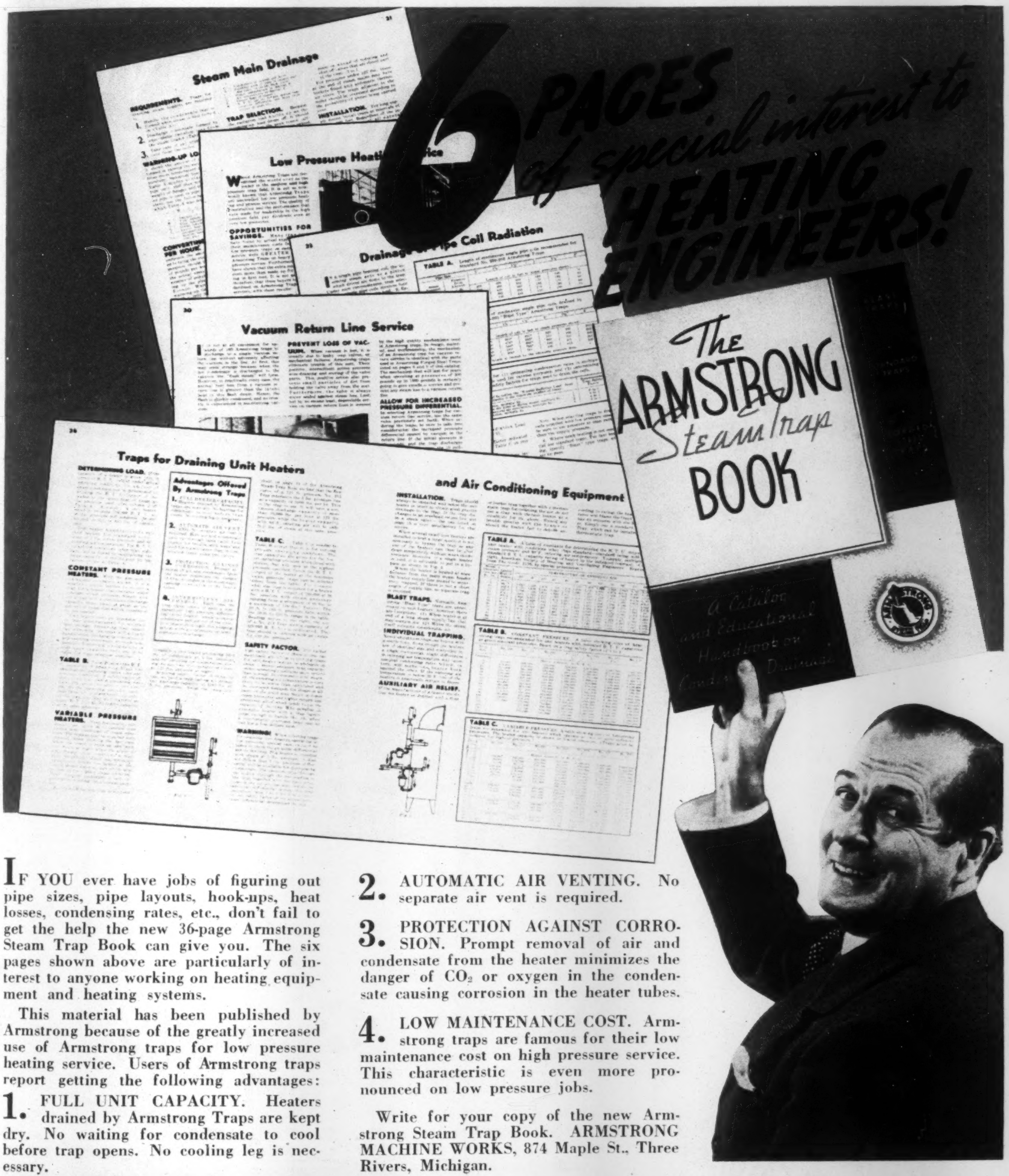
6 **Dust-Stops come** promptly when you order them. No waiting. Your air-conditioning manufacturer, jobber or dealer has a supply of No. 1 (1-inch) and No. 2 (2-inch) always on hand. Order from them today or write: Owens-Corning Fiberglas Corporation, Toledo, Ohio.

FIBERGLAS* DUSTOP* AIR FILTERS

*T. M. REG. U. S. PAT. OFF.

Made by Owens-Corning Fiberglas Corporation, Toledo, Ohio

DIRECT CANADIAN INQUIRIES TO FIBERGLAS CANADA, LIMITED, OSHAWA, ONTARIO


6 PAGES of special interest to HEATING ENGINEERS!
Steam Main Drainage
Low Pressure Heating Service
Drainage of Pipe Coil Radiation
Vacuum Return Line Service
Traps for Draining Unit Heaters
and Air Conditioning Equipment
The ARMSTRONG Steam Trap BOOK
A Catalog and Educational Handbook on Condensate Drainage

IF YOU ever have jobs of figuring out pipe sizes, pipe layouts, hook-ups, heat losses, condensing rates, etc., don't fail to get the help the new 36-page Armstrong Steam Trap Book can give you. The six pages shown above are particularly of interest to anyone working on heating equipment and heating systems.

This material has been published by Armstrong because of the greatly increased use of Armstrong traps for low pressure heating service. Users of Armstrong traps report getting the following advantages:

1. FULL UNIT CAPACITY. Heaters drained by Armstrong Traps are kept dry. No waiting for condensate to cool before trap opens. No cooling leg is necessary.
2. AUTOMATIC AIR VENTING. No separate air vent is required.
3. PROTECTION AGAINST CORROSION. Prompt removal of air and condensate from the heater minimizes the danger of CO_2 or oxygen in the condensate causing corrosion in the heater tubes.
4. LOW MAINTENANCE COST. Armstrong traps are famous for their low maintenance cost on high pressure service. This characteristic is even more pronounced on low pressure jobs.

Write for your copy of the new Armstrong Steam Trap Book. ARMSTRONG MACHINE WORKS, 874 Maple St., Three Rivers, Michigan.

Use ARMSTRONG TRAPS *on* Low Pressure Heating Systems

Marked Advantages of DETROIT "DURA-FRAM" VALVES

SINGLE DIAPHRAGM CONSTRUCTION

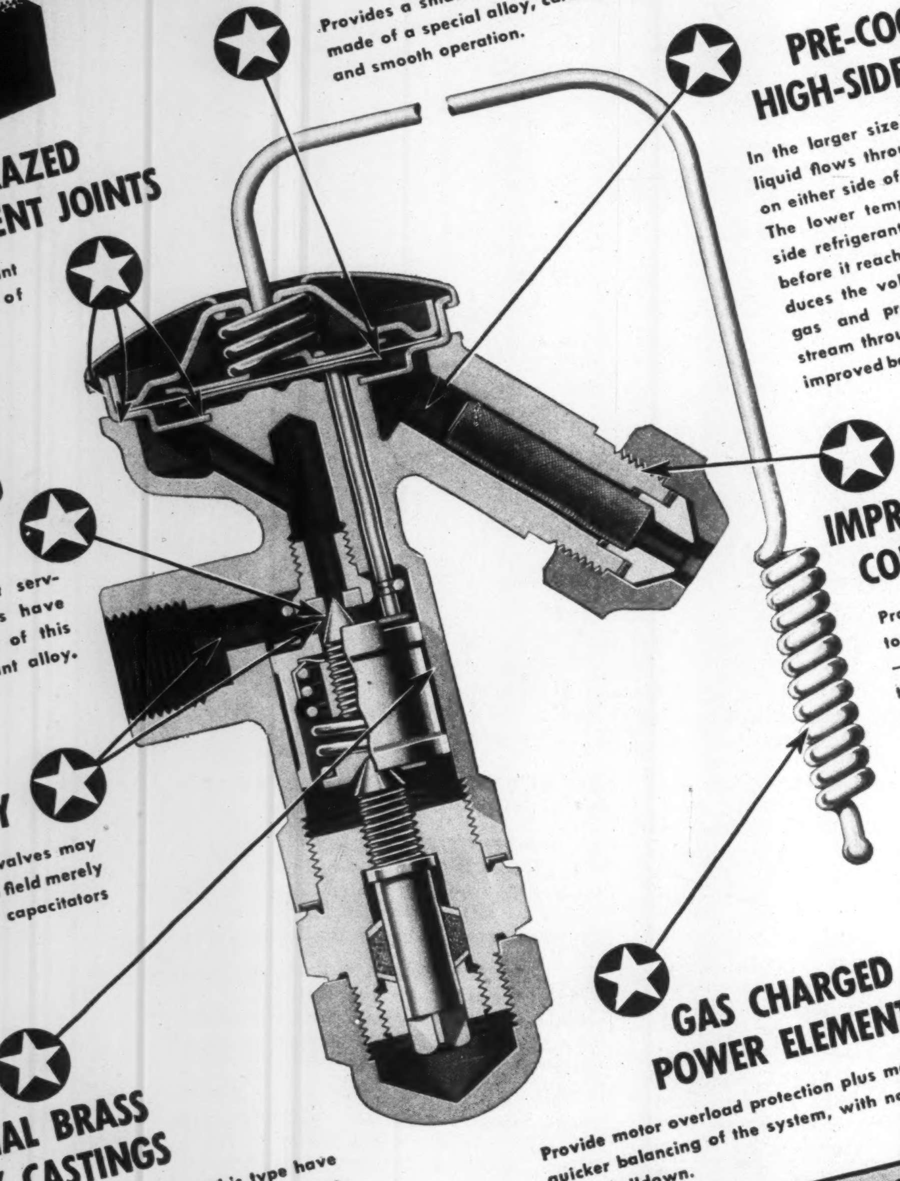
Provides a smaller, more compact valve easier to handle and install. Diaphragms made of a special alloy, carefully tested for flexibility to assure uniform capacities and smooth operation.

PRE-COOLED HIGH-SIDE LIQUID

In the larger size valves high side liquid flows through twin passages on either side of the outlet passage. The lower temperature of the low side refrigerant pre-cools the liquid before it reaches the orifice. This reduces the volume of entrained gas and produces a denser stream through the orifice with improved balance in the system.

SILVER-BRAZED POWER ELEMENT JOINTS

A superior type of joint—prevents leakage of refrigerant.



DELUBALOY NEEDLES AND SEATS

Four years of constant service in Detroit valves have proved the superiority of this hard, corrosion resistant alloy.

IMPROVED INLET CONNECTION

Provides more room to make connections—simplifies installation on both new and service work.

FLEXIBILITY

Capacities of the larger valves may be readily changed in the field merely by changing selective capacitators or seat assembly.

GAS CHARGED POWER ELEMENTS

Provide motor overload protection plus maximum sensitivity, quicker balancing of the system, with no floodbacks and no lag in pulldown.

SPECIAL BRASS BODY CASTINGS

Although more expensive to produce, castings of this type have made such a perfect record in earlier Detroit valves that they are used also for "Dura-fram" Valves.

TAKE ADVANTAGE OF YOUR JOBBER'S COOPERATION

DETROIT LUBRICATOR COMPANY
General Offices: DETROIT, MICHIGAN
Canadian Representatives—RAILWAY AND ENGINEERING SPECIALTIES LIMITED, Montreal, Toronto, Winnipeg

COPPER PIPING *Solder* FITTINGS

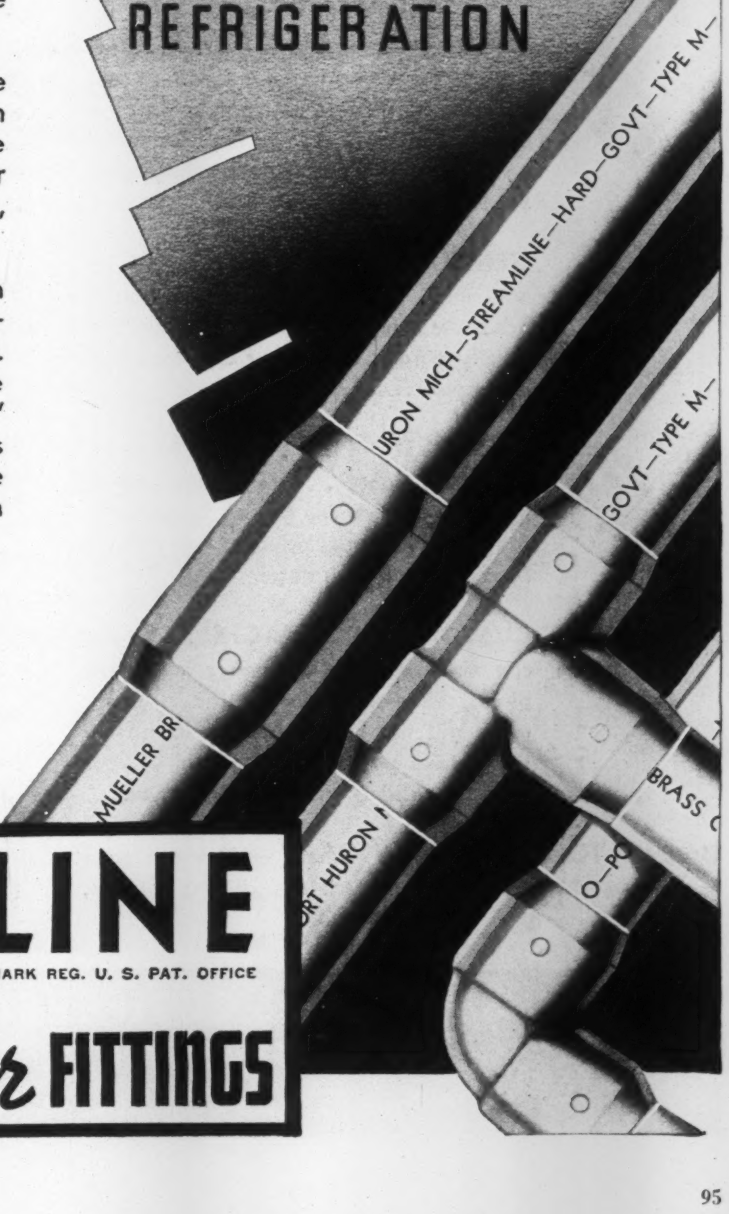
FOR HOT AND COLD WATER LINES THROUGHOUT THE BUILDING
FOR HOT WATER, VAPOR OR STEAM HEATING LINES
AIR CONDITIONING
REFRIGERATION

● The installed cost of STREAMLINE Copper Pipe and Solder Fittings is very little, if any, higher than rustable materials; yet it has outstanding advantages for countless uses in piping jobs where temperature and pressure are not excessive—and as a rule, its first cost is its final one. It cannot rust. Its ultra-smooth interior finish offers no anchorage point for the accumulation of scale or other foreign matter. It is easily installed in the closest quarters. It is a space economizer.

The transmission of heat through Copper Pipe is effected more rapidly and with less heat loss by radiation than through any other piping materials used for the purpose. There are savings in insulating materials too.

STREAMLINE Copper Pipe and Fittings are the ideal material for concealed convection type heaters, unit heater coils, gas fired type boilers, indirect water heaters, booster heater coils, humidifiers, dehumidifiers, condensers, and the multitude of other uses.

STREAMLINE Solder Fittings are furnished in Cast Bronze, Forged Brass or Wrought Copper with or without feed holes, as preferred. STREAMLINE Cast Bronze Solder Fittings are manufactured in complete range from 1/4" to 12" inclusive. All sizes of reducing fittings are available. For best results use STREAMLINE Copper Pipe, connect it with STREAMLINE Fittings . . . ALWAYS.



STREAMLINE
PIPE AND FITTINGS DIVISION
MUELLER BRASS CO.
PORT HURON, MICHIGAN

STREAMLINE
TRADE MARK REG. U. S. PAT. OFFICE
COPPER PIPE AND *Solder* FITTINGS

5 big features *make this* Industrial Advertising Conference *a "must" for you!*

"CLINICS" . . . informal group discussions of "Tying in Advertising with Selling," "Getting Salesmen's Cooperation," "Direct Mail," "Measuring Results," "Market Information," "Copy Testing," "Programs that Management Will Approve," "Layout, Copy and Illustration," "Allocation of Budgets" and other problems. *Inside information on successful methods and campaigns,* and an opportunity to have *your questions answered.*

ADVERTISING DISPLAY . . . direct mail, publication ads, sales literature and company magazines that are being used by hundreds of large and small industrial advertisers. Awards for outstanding work. *Stimulating source of new ideas.*

GENERAL SESSIONS . . . led by national authorities, on current industrial advertising and sales developments. Enable you to *keep abreast of trends that affect your business.*

RELAXATION . . . annual banquet, show, and dance . . . publishers' reception . . . opportunity to visit friends . . . program for wives, including trip through Ford's Greenfield Village.

CUSTOMER CONTACTS . . . you can visit important customers in Detroit plants, see your company's products being used, get first-hand reactions to advertising, take photographs for use in your 1941 advertising and sales promotion.

GOING TO BUY A NEW CAR? — You can save money by taking delivery in Detroit and driving it home.

Markets and selling conditions are changing. But profitable sales await those alert companies who study the trends and improve their practices. At this Conference you will get new ideas that will help you do a better, more efficient job, and make your 1941 advertising and sales promotion program more effective.

All Industrial Advertising and Sales Executives Are Invited

If your company sells to other business organizations, rather than to the general public . . . you will find this Conference devoted 100% to ***your*** problems. You are invited to attend, whether or not you are a member of N. I. A. A.

Write now for program and advance registration form, to Mr. Henry Doering, Registration Chairman, Truscon Laboratories, Inc.; Box 69, Milwaukee Junction P. O., Detroit, Mich.

Advance Registration Saves You Time and Trouble

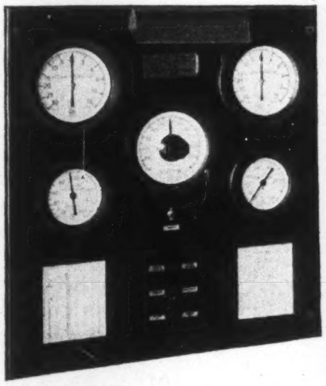
No waiting to register . . . your Conference and hotel registrations will be made in advance . . . card, badge, program and room key ready when you arrive—pay $10 Conference fee and go directly to your room or to first meeting.

18th Annual **CONFERENCE** *and Exposition*
National **INDUSTRIAL ADVERTISERS** *Association*
SEPT. 18, 19, 20 . . . DETROIT . . . HOTEL STATLER

ILLINOIS SELECTIVE PRESSURE CONTROL SYSTEMS
Heat Conditioning for Comfort
SELECTOR

MODERNIZE

Your Heating System NOW . . . for the Comfort and Economy of Controlled Heating



Your present vacuum or vapor system, regardless of size, may be changed over at low cost to an

ILLINOIS SELECTIVE PRESSURE SYSTEM

. . . a *new* and *exclusive* development that gives the convenience and economy of perfect heat control . . . a small investment that will return big dividends in fuel saving, heating comfort and satisfaction.

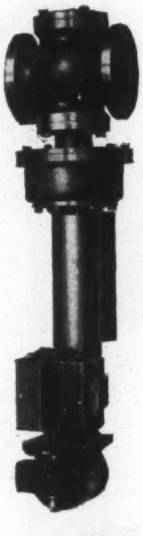
●

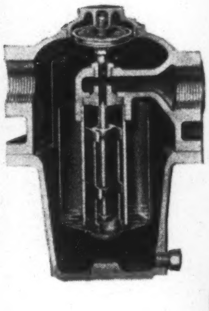
Illinois Selective Pressure Control Systems are individually engineered to meet every condition of steam circulation and regulation of combustion. They open a new field for control systems in apartments, schools, churches, commercial and public buildings—control that heretofore has been adaptable only to the larger heating installations.

That these systems are in wide use in leading universities and engineering schools offers convincing evidence of their outstanding merit.

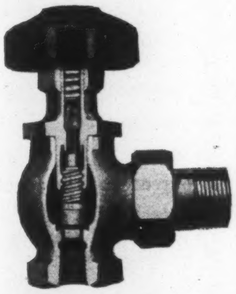
FOR FURTHER INFORMATION

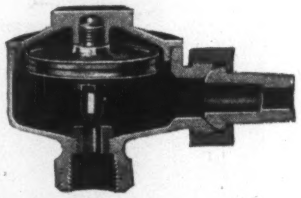
SEE OUR CATALOG IN SWEET'S





Write for bulletins 16, 517 and 62 or phone our representative in your territory for full details.

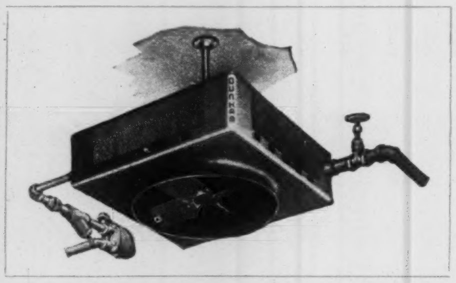




ILLINOIS ENGINEERING COMPANY
2045 SOUTH RACINE AVENUE, CHICAGO

Equipment DEVELOPMENTS

Unit Heater

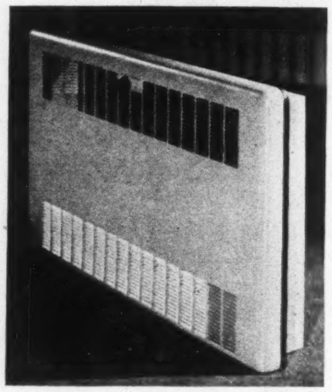


No. 1912—A specially designed unit heater for industrial and commercial applications is designed throughout for its specialized function of driving a large volume of heated air at relatively high velocity and low temperature down to working levels, the manufacturer states.

High ceilings in factories, high clearances necessary for industrial equipment such as cranes, over-doorway heat requirements of stores and office buildings, and small rooms where one unit only may be required, are typical of the conditions which this heater is designed to meet.—C. A. Dunham Co., 450 E. Ohio St., Chicago, Ill.

For your convenience in obtaining more information about any of this equipment, see coupon on page 110. Add the new products and companies listed here to your Directory Section which you received in your January, 1940, HEATING, PIPING AND AIR CONDITIONING and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed

Convectors

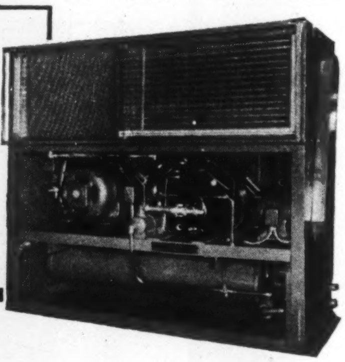


No. 1913—In presenting a 1940 line of convectors, the manufacturer offers a wide variety of sizes, styles and models. New models have a lock type front to facilitate easy installation and cleaning. Another feature is a tight seal against the wall even with the varying wall lines frequently encountered in building construction, it is stated.

There are free standing floor cabinet convectors which are primarily used in modernizing buildings—although they have a definite field in new buildings as well. The semi-recessed styles go a long way toward saving floor space and achieving a harmonious interior and their application is universal.

You Offer All These Advantages with

CURTIS PACKAGED Air Conditioners



Above: 7½, 10, 15 ton Remote or Central Type Air Conditioner.

The complete Curtis line of Packaged Air Conditioning Units includes 5 sizes from 3 to 15 tons capacity. With this line you can meet the requirements of practically every class of retail establishment; offices, stores, restaurants, institutions, etc.

In addition, Curtis Packaged Units offer you and your customers *all* these important advantages — all sound, attractive sales points that mean increased sales and profits for you:

- Low first cost — low operating expense
- Easily installed in one day
- Easily moved if desired
- Units cool, dehumidify, circulate and filter the air
- Attractive exterior appearance
- Adaptable for heating purposes
- Readily financed
- Correctly balanced — precision engineered, assembled and tested at the Curtis factory

Curtis provides an opportunity for you to get your share of profits from the vast packaged air conditioning market that is widening day by day. A letter will bring you complete information on the complete Curtis line.

Below: 3 and 5 ton Packaged Type Air Conditioner.

CURTIS REFRIGERATION
AIR CONDITIONING AND COMMERCIAL

Established 1854

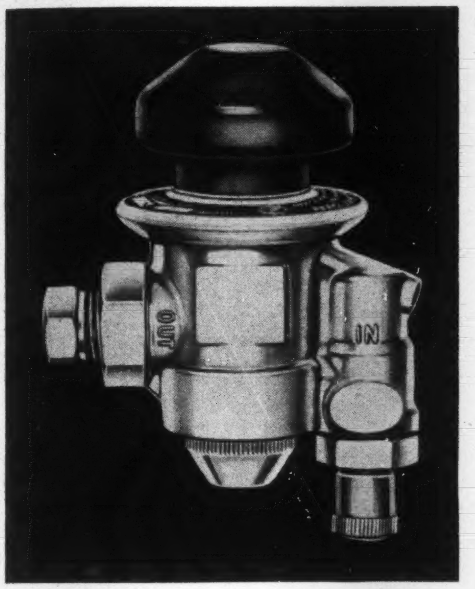
CURTIS REFRIGERATING MACHINE CO.

Division of Curtis Manufacturing Co.

1950 Kienlen Ave. St. Louis, Missouri

dependable A-P valves . .
control refrigeration

DEPENDABLE



DEPENDABILITY IN A-P VALVES . . .

When you've sunk a couple of days' hard work on an installation that cost your customer many dollars, it's good to know that the "little things" . . . *like the Expansion Valve or Solenoid Valves* . . . can be depended upon to protect all your skill and labor.

That's the main reason Service Men and installing Engineers so enthusiastically demand A-P Valves for Refrigerant Control on every job.

A-P Model 204 AUTOMATIC EXPANSION VALVE

Small, compact, designed for fractional tonnage units such as Domestic Refrigerators and Beverage Coolers. Provides easy and accurate adjustment of back pressure.

Rated ¼ ton Freon, ½ ton Methyl or Sulphur. Has handy Wrench Pads, Moisture-proof Breather Cap, Large, Adequate Strainer. Non-chattering construction. *A typical A-P* DEPENDABLE *Valve.*

It's priceless . . . this DEPENDABILITY so long attached to A-P Products! And it's YOURS, to help you to profits on every installation. Use it!

A-P builds DEPENDABILITY *into a full line of Thermostatic Expansion Valves, Solenoids, Suction Pressure Valves, Water Valves, Temperature Control Sets, and the new* "TRAP-IT" *System-Protectors.*

● Progressive Service Men Use and Recommend—and Aggressive Jobbers Stock and Talk—A-P Products.

AUTOMATIC PRODUCTS COMPANY
2460 NORTH THIRTY-SECOND STREET
MILWAUKEE WISCONSIN
Export Department, 100 Varick Street, New York City

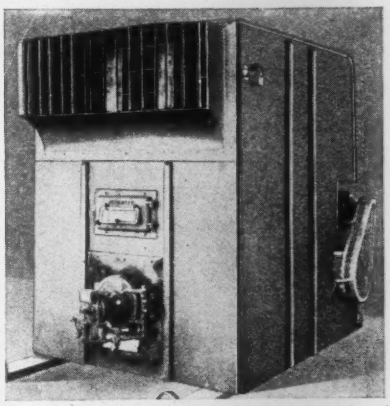
The DIRECTHERM, DIRECT-FIRED UNIT HEATER

SOLVES DIFFICULT HEATING PROBLEMS *for* MANY INDUSTRIES

Direct-Fired Unit Heaters for Oil, Gas or Coal *(hand or stoker fired)*

for

- Warehouses
- Assembly Plants
- Foundries and Mills
- Airplane Hangars
- Isolated Buildings of all types (remote from steam plant)



Oil-Fired Directherm Unit Heater

Directherm Unit Heaters are "one-package" heating plants ranging in capacity from 300,000 to 1,500,000 BTU's. These units wherein the heat of combustion is immediately transferred to heating purposes are high in efficiency, low in installation and maintenance cost and their use is flexible because of their ready portability and ease of hooking up. The Directherm Unit Heater is equipped with a multi-blade centrifugal fan which distributes the warm air throughout the area to be heated.

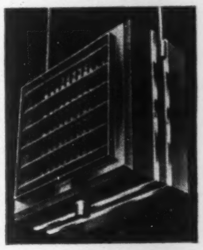
SIX STANDARD SIZES—300,000 TO 1,500,000 BTU'S.

Directherm direct-fired Unit Heaters are available in six standard sizes, capacities ranging from 300,000 to 1,500,000 Btu's. The Units are made of heavy steel plate, with major sections all-welded. Flue gas headers are readily cleanable.

VENTILATION AND AIR RECIRCULATION. The Directherm can be easily hooked up for outside air intake. Air filters may be used in the intake box when desired.

INSTALLATION. These units, when assembled, require nothing more than a stack and an electrical connection (plus a gas or oil fuel hook-up) and can be made fully automatic in operation when using oil, gas or stoker.

WRITE FOR BULLETIN AND TECHNICAL DETAILS



The Airvector

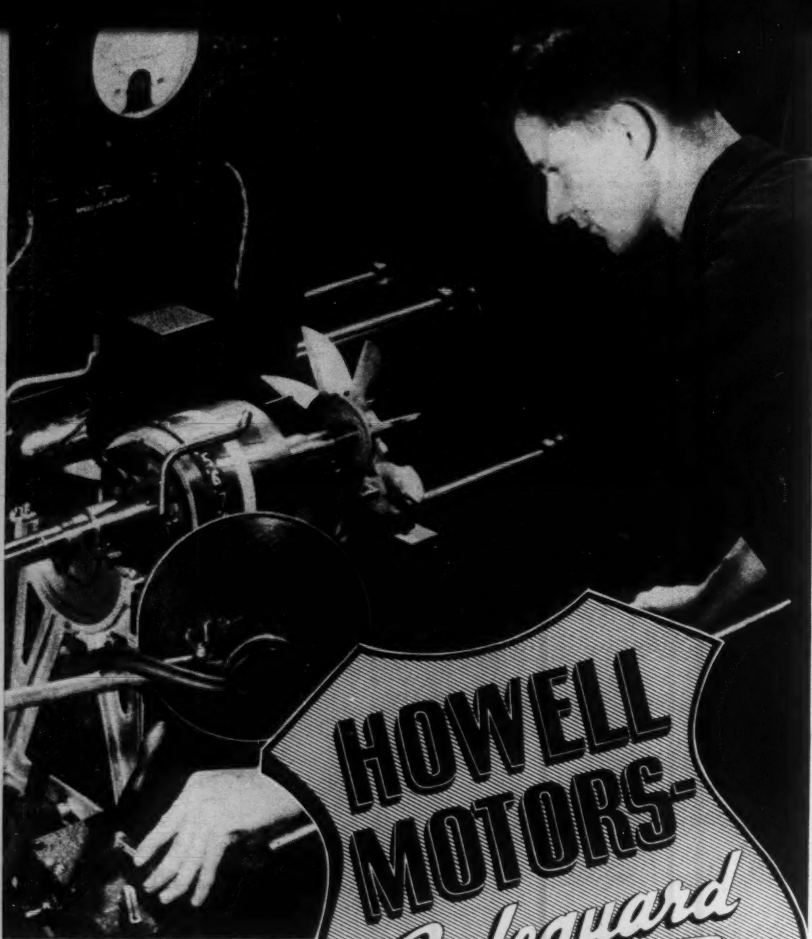
AIRTHERM STEAM UNIT HEATERS

For All Heating Purposes

AIRTHERM UNIT HEATERS are made in both the propellor fan type (The Airvector) and the centrifugal fan type (The Airheator). Airvectors are available for wall or ceiling mounting. Airheators are heavy duty, large capacity unit heaters and are available in designs for ceiling, wall and floor mounting. For complete details, ask for special bulletins on Airheators and Airvectors.

FACTORY REPRESENTATIVES. A few territories still open.
Write for details.

AIRTHERM
MANUFACTURING COMPANY
712 S. Spring Ave. St. Louis, Mo.


HOWELL MOTORS- Safeguard Your Conditioning Installations

EXAMPLES OF PRECISION

One in a Series of Advertisements, "HOWELL Motors in the Making" —showing how modern precision standards maintain HOWELL quality. . . .

PRECISION METHOD of ELIMINATING DESTRUCTIVE VIBRATION

At HOWELL every rotor assembly is subjected to a DYNAMIC BALANCE TEST, using the most sensitive testing equipment obtainable.

Testing procedure is illustrated above. Each rotor assembly is operated at approximately the rated speed of the completed motor — the stroboglow lamp showing exact location of unbalance—the electronically operated meter indicating amount of unbalance. Correction for balance is made possible by this accurate information.

The precision-balanced HOWELL rotor assembly is a SAFEGUARD of first importance against undue vibration which causes noise and excessive bearing wear.

Complete Line – Fast Delivery

For 25 years HOWELL has specialized on polyphase motors for air conditioning, ventilating and heating drives. Motors can be furnished with any electrical and mechanical characteristics required — ½ to 150 HP, single or multi-speed.

Whatever your drive needs, HOWELL can meet them EXACTLY and on time. Write us, outlining your particular problem!

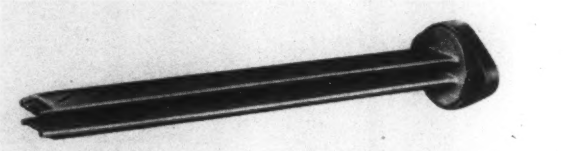
HOWELL ELECTRIC MOTORS COMPANY
HOWELL, MICHIGAN
Representatives in All Principal Cities

according to the maker. Wall cabinet models hang from the wall as their name suggests, and are completely off the floor; they are particularly adapted to hospitals, offices, apartments, schools and public buildings already built, or in new buildings where the wall construction does not permit concealment. The sloping top wall cabinet goes a step further in that its sloping top makes it impossible to place objects or to sit on the cabinet. The recessed cabinet and plaster cabinet meet exacting interior decoration requirements for all classes of buildings. With the recessed cabinet, the panel is flush with the wall and may be finished to match the wall or grained to match the woodwork. The plaster cabinet may be used where it is desirable to carry the wall finish across the front of the convector.

All cabinets are available with either the "Free-Flo" grille or the "Double-Formed" grille.—Trane Co., La Crosse, Wis.

Electric Immersion Heaters

No. 1914—Among the recent developments in the "Chromalox" line of electric heating equipment is an immersion heater for water and oil. It is installed by bolting in place against a flat gasket seat (the gasket being furnished with the heater). If the tank or container is sheet metal, a companion flange or bushing holds the heater in place.



Features include—states the maker—the patented heating element construction for efficient heat transfer and long life, large heat surface of rectangular cross-section for efficiency and strength, and the fact that all immersed sections are of tinned copper. These heaters are available in ratings (for water heating) of 750 to 5000 watts.—Edwin L. Wiegand Co., 7610 Thomas Blvd., Pittsburgh, Pa.

Whiteprint Machine

No. 1915—The new model "F" whiteprint machine offers a fast, economical, convenient and efficient method of making positive-type reproductions of engineering drawings, letters, charts, diagrams, bulletins, reports, etc., according to the maker, who states it has a printing speed up to a maximum speed of 56 in. per min. The light source used consists of a new type high pressure mercury vapor lamp which uses 40 watts per in. with an active length of 46 in.

Other features are:

Revolving glass contact to provide maximum light utilization and avoid slippage, friction, static and dragging of paper and tracings across stationary glass.

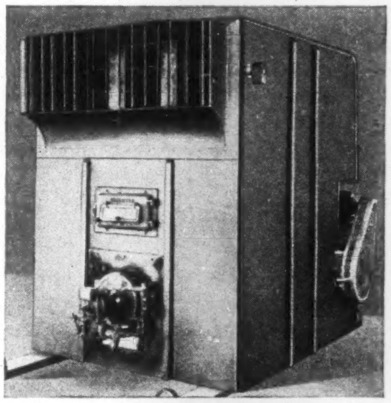
Adjustable light shade to allow operator to vary exposure without changing printing speed, thus making it possible to handle prints efficiently and maintain a smooth flow of work despite variations in transparency of tracings.

Forced air cooling system for even cooling of the lamp necessary for uniform light distribution.

Special transformer to correct the power factor to 87.5 per cent.
—Ozalid Corp., Ansco Rd., Johnson City, N. Y.

Oil Fired Heaters

No. 1916—"Directherm" unit heaters are now available as oil burning units in six standard sizes with capacities ranging from 300,000 to 1,500,000 Btu.



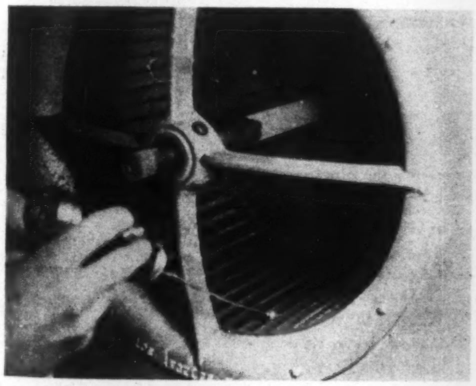
The oil burning unit has been especially developed to meet the particular requirements of direct firing wherein the heat of combustion is immediately converted to actual heating purposes with minimum loss, according to the maker. The heater can be set up for full automatic control both as to room temperature and as to delivery temperatures of the warm air at the unit. It is a self-contained heating system with comparatively low outlet temperatures and a horizontal high velocity air stream with an adjustable wide angle of delivery.

A multi-blade centrifugal fan distributes the warm air directly from the unit, throughout the area to be heated. Duct work, however, can be used where required.

These heaters are also available for gas or coal firing (stoker or hand).—Airtherm Mfg. Co., 720 S. Spring Ave., St. Louis, Mo.

Flashlight Bulb Extension

No. 1917—For those requiring a closely spotted light in difficult to get at places, a novel flashlight bulb extension has been developed. Working in restricted places, the ordinary flashlight is often inadequate. With the device, vision is aided and both hands are freed. This is made possible because the extension is bendable and can be made to hook on any object or shaped to form its own stand.



The extension is made of special wire encased in aluminum alloy tubing and is waterproof.—Sierra Aircraft Co., Sierra Madre, Calif.

Motor and Pump Unit

No. 1918—The line of multi-stage "SSUnit" pumps, in which the motor and pump housings are bolted together for compactness, has recently been extended and includes a new two stage pump with 4 in. suction and 2 in. discharge that can be rated up to 275 gpm against heads up to 500 ft at a speed of 3550 rpm.

PIONEERING ILG LEADERSHIP

"Firsts"

NUMBER
3
OF A SERIES

WITH SELF-COOLED
MIRACLE MOTOR
THAT "BREATHES"
Never "Slow Roasts"

ILG Vital Zone*
UNIT HEATERS

First in the field with propeller fan steam unit heaters (1916) . . . ILG has now produced a brand new booklet picturing latest developments in this money-saving type of heating system—outlining the advantages of unit heaters over radiators or pipe coils—listing the savings accruing to users—illustrating exclusive ILG features, such as the self-cooled miracle motor that never "slow roasts"—and graphically showing how the "Vital Zone", that area where people work, shop and play, can be most effectively, efficiently and economically heated. A copy is yours for the asking — write today for Catalog No. 128!

* WHERE PEOPLE WORK, SHOP AND PLAY!

OTHER ILG "Firsts"

- ★ Placed direct-connected propeller fans on production basis—1906
- ★ Popularized direct-connected blowers—patented 1910
- ★ Floated drive for blowers—1932
- ★ Variable air control for blowers—1926
- ★ Type C (condenser-type) Motors—1925
- ★ Penthouses or power roof ventilators—1915
- ★ Automatic shutter—1907
- ★ Motor operated shutter—1918
- ★ Solenoid operated shutter—1907
- ★ Self-contained electric unit heater—1917
- ★ ILGATTIC system of summer cooling—1918
- ★ Portable type kitchen ventilating fans—1918
- ★ Built-in type kitchen ventilating fans—1925
- ★ Transom type kitchen ventilating fans—1925

"FIRST" IN DEVELOPMENT
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- ★ Two-piece graduated Header for trouble-free operation.
- ★ "Wedded" Copper Tubes and Fins—no oxidation of contact surfaces, no brazing, soldering or welding.
- ★ Coil contracts or expands independent of casing.
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- ★ Quiet, powerful, long-life operation—famous ILG "ONE-NAME-PLATE" guarantee.

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UNIT HEATERS

RIC-WIL Insulated PIPE UNITS

—a speedy installation for Rochester Gas & Electric Corp.

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160 Feet -23 HOURS !
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THIS underground steam line, serving the Seneca Hotel, Rochester, N. Y., had to be installed completely between Saturday night and Monday morning, under a heavy traffic lane. This was accomplished, including back-filling and repaving, in 23 hours total elapsed time!

If, in addition to engineering dependability and long life, you want *speed* and *economy*—Ric-wiL Insulated Pipe Units can serve you too. Complete factory assembled units, in any lengths, with pipe covering as specified, and all necessary fittings, steam pipes furnished by customer or by us.

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The Ric-wiL Co., Union Commerce Bldg., Cleveland, O.

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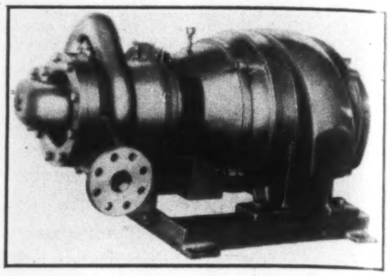
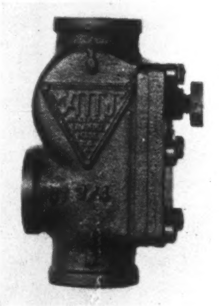
CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES



The new pump, like the maker's smaller multi-stage pumps of this type, has cast iron casing and cover and is bronze fitted throughout. The impellers are placed back to back to provide axial balance. The cover can be readily taken off, permitting the inside parts to be removed without disconnecting the suction and discharge piping. Suitable as a small boilerfeed pump, mine pump or pipe line pump. It can be used in humidifier work, air conditioning service, oil loading and many other small capacity, high pressure services, according to the manufacturer.—Allis-Chalmers Mfg. Co., Milwaukee, Wis.

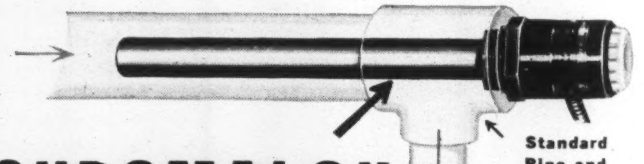
Circulation Controller

No. 1919—The "No. 73" circulation controller illustrated has recently been made available in larger sizes and can now be had in a range from ¾ to 2 in. inclusive.



It is offered for the direct control of domestic hot water temperature. It controls the temperature of water delivered to the tank by an indirect heater to maintain a maximum predetermined temperature. It is of all bronze construction and has a corrosion resisting thermostat. The standard setting is 140 F and the adjustment range 120 to 180 F.—Watts Regulator Co., 10 Embankment St., Lawrence, Mass.

How to use ELECTRIC HEAT to boost pipe line temperature


Standard Pipe and Fittings

CHROMALOX IMMERSION HEATER

with cylindrical heated section constructed to screw into one end of a standard pipe "T", thus projecting the heated section into the pipe contents. These immersion heaters—Types RI and RIO—are available with screw plug for standard pipe thread as small as ½ in., and larger up to 1¼ in. Sheaths of steel or copper, for immersion in oil or water. Besides use in circulating lines, these units are valuable for insertion in tanks containing paraffin or other non-fluid substance.

Complete details on this and many other electric heat applications may be had upon request to the Wiegand engineering staff, who offer cooperation on any specific heating problem.

ELECTRIC HEAT for many uses

is covered in the Chromalox Book of Electric Heat, comprising 64 pages of valuable application data, and description of the many types of electric heating units available for industrial purposes. Your request brings a copy of this book.

EDWIN L. WIEGAND COMPANY
7610 Thomas Blvd. Pittsburgh, Pa.

Conventions and Expositions

Air Conditioning Short Course: August 15-17, Agricultural and Mechanical College of Texas, College Station, Tex. Sponsored by department of mechanical engineering, W. E. Long, chairman.

American Society of Mechanical Engineers: Fall meeting, September 3-6, Hotel Davenport, Spokane, Wash. Headquarters office, 29 W. 39th St., New York, N. Y.

Eastern States Exposition: September 15-21, Springfield, Mass. For further information address J. H. Fifield, Eastern States Exposition, Springfield, Mass.

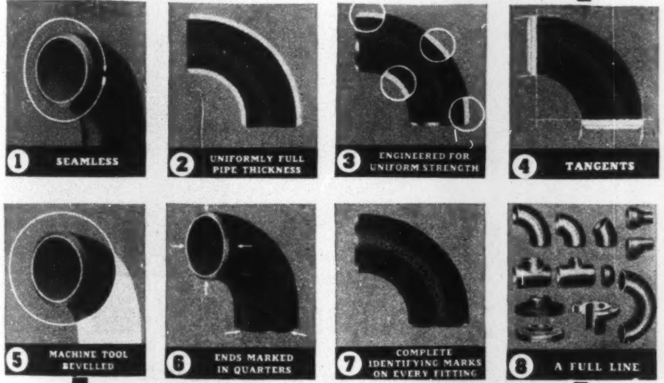
National Industrial Advertisers Association: Annual Conference and Exposition, September 18-20, Hotel Statler, Detroit, Mich. President, Charles McDonough, Combustion Engineering Co., Inc., 200 Madison Ave., New York, N. Y.

Iron and Steel Exposition: September 24-27, Hotel Stevens, Chicago, Ill. Sponsored by Association of Iron and Steel Engineers, 1009 Empire Bldg., Pittsburgh, Pa.

American Society of Heating and Ventilating Engineers: Fall meeting, October 14-15, Rice Hotel, Houston, Tex. A. V. Hutchinson, secretary, 51 Madison Ave., New York, N. Y.

American Welding Society: Annual meeting, week of October 20, Cleveland Hotel, Cleveland, Ohio. Headquarters office, 33 W. 39th St., New York, N. Y. Tentative program includes papers on welding of carbon-molybdenum piping for high pressure, high temperature service, by R. W. Emerson; pipe welding for naval service, by Bela Ronay; arc and gas welding piping, by Eric Seabloom; and codes for welding pressure vessels, by D. S. Jacobus.

THERE are no "just-as-good" fittings. WeldELLS alone offer you all these eight aids to faster, easier welding.



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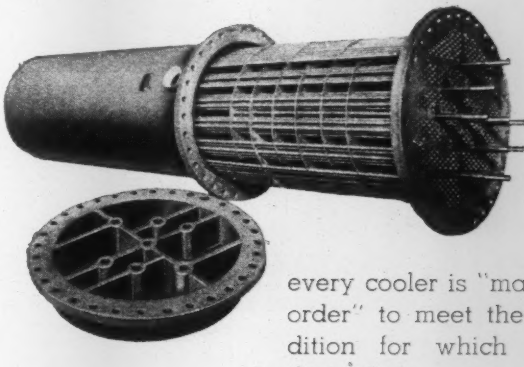

Everything that might possibly affect its perfect operation is carefully taken into consideration . . . and our experience of 60 years in the manufacture of heat transfer equipment enables us to work out such problems with exactness.

When you have another air conditioning problem, let's talk it over without obligation on your part.

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The Patterson-Kelley Co., Inc.
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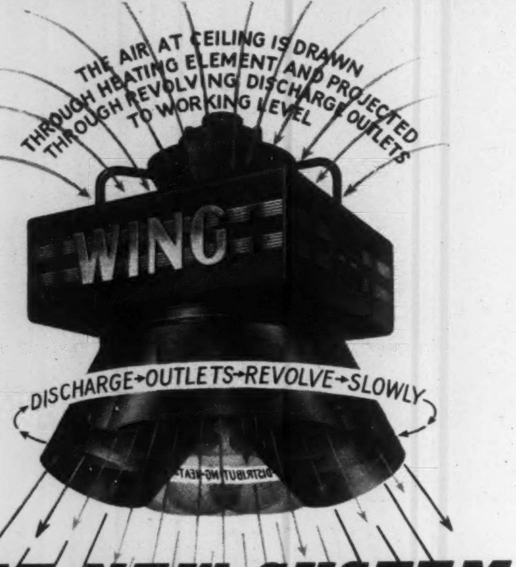
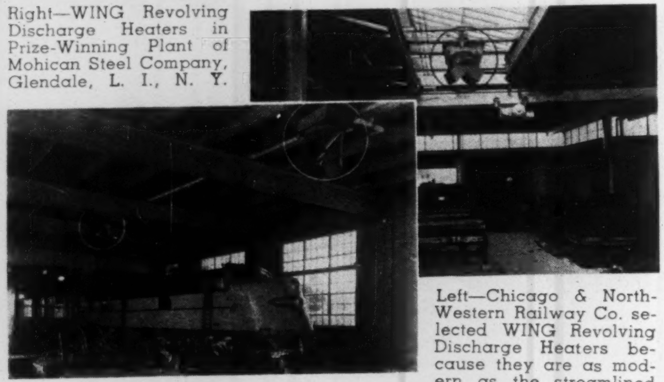
Patterson Freon Water Coolers


THE AIR AT CEILING IS DRAWN THROUGH HEATING ELEMENT AND PROJECTED THROUGH REVOLVING DISCHARGE OUTLETS TO WORKING LEVEL
WING
DISCHARGE→OUTLETS→REVOLVE→SLOWLY

THE NEW SYSTEM OF PLANT HEATING

Slowly revolving outlets . . . an innovation which assures THOROUGH heat distribution . . . a sensation of heating comfort never before attained . . . the air feels alive and invigorating.



Right—WING Revolving Discharge Heaters in Prize-Winning Plant of Mohican Steel Company, Glendale, L. I., N. Y.

Left—Chicago & North-Western Railway Co. selected WING Revolving Discharge Heaters because they are as modern as the streamlined locomotive.

No other single factor is more important than heating in assuring comfort to factory workers who will be "under pressure" this Fall and Winter, due to National Defense programs. Comfortable working conditions are not left to chance when the WING System of Heating is adopted in a plant.

WING Heaters provide the utmost in comfort in plants like General Motors, Linden, N. J., Wright Aeronautical Corp., Paterson, N. J., Dodge Truck Plant, Detroit, Mich., United Aircraft Corp., E. Hartford, Conn., New York City Omnibus Corp., N. Y. C., and many others.

In installations like these, each heating problem called for a distinct, individualized application. WING engineers—equipped with years of experience and research in heat distribution, and backed by the pioneer developer of "Floodlight Heating"—can prescribe an installation to solve your heating problem.

WING Heater Bulletin H-8 contains installation diagrams, piping details, and other interesting data. May we send a copy?

L. J. WING MFG. CO.,
14th St. & 7th Ave., New York, N. Y.

WING REVOLVING DISCHARGE UNIT HEATERS

Booklets, Reports and Papers

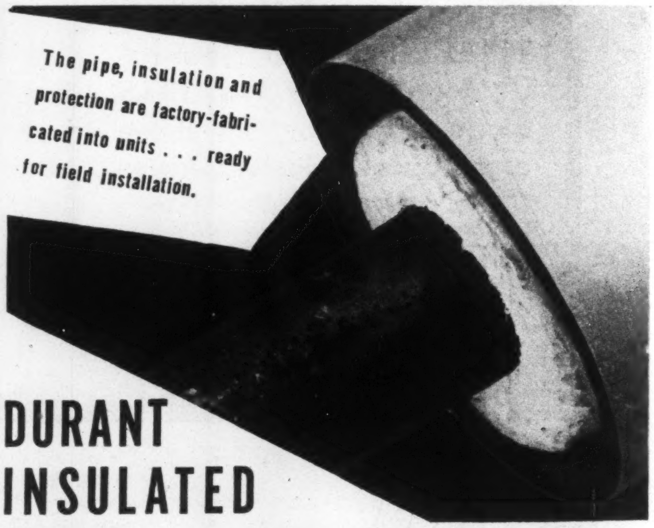
Heat Flow Through Sunlit Walls

Estimating the flow of heat through sunlit walls and roofs, a problem of great importance in air conditioning, has been worked out mathematically by Professor C. O. Mackey and a graduate student, L. T. Wright, Jr., in the College of Engineering, Cornell University, Ithaca, N. Y. Their findings have now been brought together as Reprint No. 9 of the Engineering Experiment Station, which is available without charge on request (as long as the supply lasts).

"An accurate estimate of the cooling load," they point out, "is essential to a selection of air conditioning equipment that will maintain the desired state of the air within an enclosure." Some solar energy is absorbed by outside surfaces of the building; maximum rate of heat reception at the outside may take place long before maximum rate of transfer to the indoor air, because of absorption of heat by the building materials; and various components of the cooling load therefore reach their peaks at different times.

Using a 12 in. concrete west wall as an example, the authors estimate the amount and rate of heat transfer from the inside surface to the indoor air at different times of day. They then indicate how the mathematical formulas may be applied to thicker walls, to composite walls and finally to specific practical problems such as estimating the hourly cooling load on the top floor of an air conditioned building which has 12 in. brick walls with plaster finish on the inside and a flat roof composed of 4 in. of concrete, 2 in. of insulation, aluminum colored roofing paper and a plastered ceiling.

Included are tables indicating the heat flow through sunlit walls of brick, stone, concrete and wood frame construction using a


The pipe, insulation and protection are factory-fabricated into units . . . ready for field installation.

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This unique system of pipe-line protection is noted for simplicity, economy and dependability. Write today for the new D. I. P. booklet.

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variety of insulating materials. Tables are also given for concrete and wood roofs with black or aluminum colored roofing, with various types of construction, thickness of roof deck and insulation, and with or without plaster ceilings underneath. The rate of heat flow is given for nine different hours of the typical day in the general latitude of the United States.

Psychrometric Charts Simplified

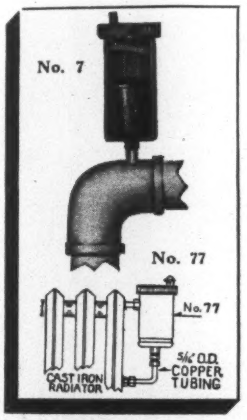
A simplified presentation of air conditioning data has just been published by Carrier Corp., 302 S. Geddes St., Syracuse, N. Y. The Carrier psychrometric chart as first published has been revised for greatest accuracy with convenience in the solution of all psychrometric problems.

The data from which the charts were plotted were contained in a paper presented by Dr. Willis H. Carrier in conjunction with Professor C. O. Mackey of Cornell University before the American Society of Mechanical Engineers in 1936. These charts make it possible to arrive at accurate solutions for all barometric pressures; this has been accomplished by the addition of a correction table which makes the charts universal in this application.

By the use of a much larger vertical scale for grains of moisture per pound of dry air and by making separate charts, accurate determinations at lower temperatures are possible.

The first chart is for wet bulb temperatures below 32 F. The second is for normal air conditioning ranges with dry bulb temperatures from 32 to 110 F. Dr. Carrier will prepare later a third chart for the high temperature range from 80 to 330 F suitable for calculations in drying and processing materials. Each of these charts permits an accuracy of reading within its entire range which is equal to the accuracy of thermometry in laboratory tests, it is stated.

Vapor pressure tables are included in the pamphlet. Also, 15 examples are worked out to show the use of the charts.



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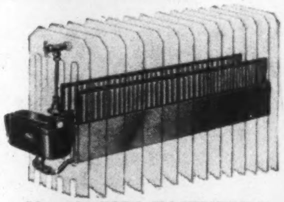
HERE'S THE ANSWER!

Whenever you're troubled with sick radiators or hot and cold circulating lines it's a pretty good bet that you can have them operating efficiently in jig time by simply installing the Nos. 7 or 77 Maid-O'-Mist Automatic Air Vents. These reliable vents have self-closing float-controlled valves, and are designed especially for circulating lines where accumulation of air retards circulation. The Nos. 7 and 77 are 2¼" x 3½", nickel plated, have ⅛" I.P. connection and operate on pressures up to 75 lbs.

Ol' Faithful Humidifier will automatically vent the radiator as well as supply ample humidity. Automatically fed by water direct from the air vent opening in the radiator or nearest water supply through a nickel-plated brass reservoir and feeder. Consists of two copper troughs which insert between sections of the radiator. Each trough is equipped with metal-edged evaporator. Available in three sizes.

Manufacturers of humidifiers for steam, hot water and warm air systems.



No. 30—"OL' FAITHFUL" HUMIDIFIER for Hot Water and Steam Radiators

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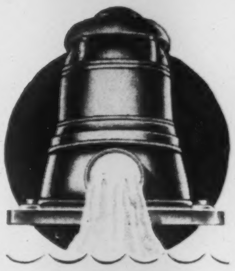
Uncompromising Quality of Materials and Workmanship make Layne Wells & Pumps

LAST LONGER

Layne is an organization of the old school. It still follows the famed rule of "make it of good materials and make it right." That is why there are Layne Wells and Pumps still in service after a quarter century of use.

Layne realizes that a well water system has to supply the daily life fluid for men and materials and then "stand by" with a reserve in strength and ruggedness to play a hero's part in an emergency of fire. Every part of a Layne well and pump is built to last and give the highest in efficiency.

Only until you have heard the full story of what Layne has to offer in the rebuilding of your old water system, or the installation of an entirely new one, will you fully appreciate their incomparable qualifications.



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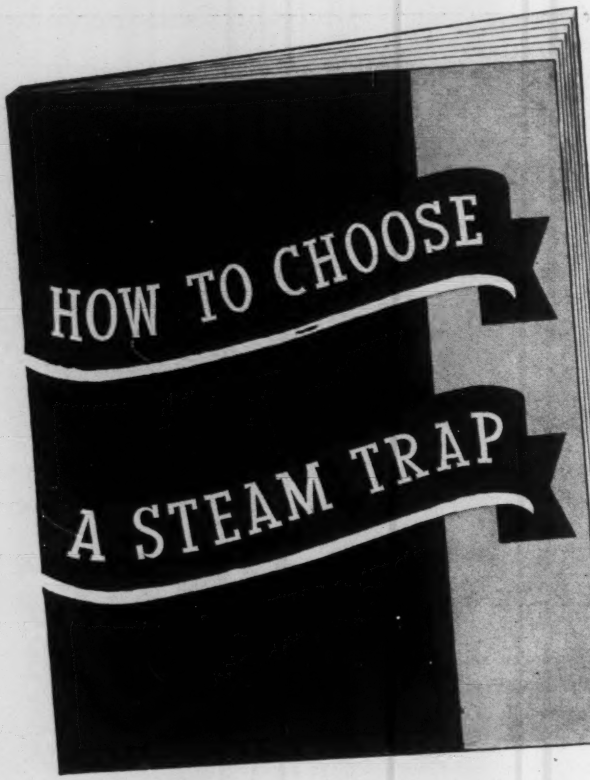

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... how to choose the right size trap, quickly and easily—for steam jacketed kettles, for sterilizers, unit heaters, submerged surfaces, etc. Shows a good method for maintaining a false water line ahead of a condensation meter. Describes an improved method of trapping autoclaves to obtain maximum temperatures (by more complete air removal). Book also explains the importance of air removal from unit heaters for corrosion prevention and tells how to achieve that removal.

Get your copy of "How To Choose a Steam Trap." Free to all bona fide steam trap users. Write today and keep it at your elbow to save time and bother.

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I would like a copy of the book "How To Choose A Steam Trap," and I understand that this does not obligate me in any way.

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Recent Trade Literature

For your convenience in obtaining copies of these bulletins, see coupon on page 110. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending your request to HEATING, PIPING AND AIR CONDITIONING.

No. 3602. AIR CONDITIONERS: Carrier Corp., 302 S. Geddes St., Syracuse, N. Y. Specification sheet covering four sizes of self-contained air conditioners, which include within a compact housing the apparatus to cool, dehumidify, filter and circulate room air and complete refrigerating water cooled condensing unit. Sizes range from 2½ to over 5 tons.

No. 3603. AIR COOLING UNITS: McCord Radiator & Mfg. Co., 2587 E. Grand Blvd., Detroit, Mich. 4 p. bulletin on suspended air cooling units for "Freon," methyl chloride, or water for use in stores, offices, restaurants, beauty parlors, etc.

No. 3604. AIR FILTER PANEL HOUSING ASSEMBLIES: Air-Maze Corp., 5200 Harvard Ave., Cleveland, Ohio. 4 p. bulletin on air filter panel housing assemblies for air compressors, internal combustion engines, blowers and other heavy duty industrial applications. They consist of filter panels held in a structure commonly known as a "dog house."

No. 3605. ALLOY STEELS: Babcock & Wilcox Tube Co., Beaver Falls, Pa. 8 p. reprint bulletin (3-266) on creep of some chromium-molybdenum steels, such as are used in the refining industry and steam superheater work. Also technical data card (No. 8) on chemical compositions of SAE steels reprinted from the SAE handbook. Also technical data card (No. 11) with information on "Croloy 2¼," an alloy developed for application in piping, steam superheating and oil refining operations.

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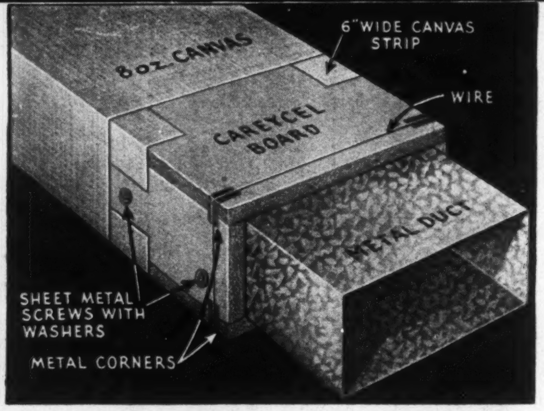

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For the insulation of ducts and all types of air-conditioning equipment, use CAREYCEL sheets and blocks—a fireproof, low-cost, high efficiency, asbestos board. Lightweight (approx. 1½ lbs. per board foot); negligible shrinkage; easy to fit and apply; makes neat appearing jobs. Write for folder and samples. Address Dept. 25.

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Dependable Products Since 1873
BRANCHES IN PRINCIPAL CITIES

No. 3606. BRAZING ALLOYS: Handy & Harman, 82 Fulton St., New York, N. Y. 4 p. folder on "Sil-Fos" and "Easy-Flo" brazing alloys, with information on use, applications and advantages.

No. 3607. CHEMICAL FEEDERS: Permutit Co., 330 W. 42nd St., New York, N. Y. 4 p. bulletin (2345) on a new oscillating type dry chemical feeder for discharging chemicals to a mixing tank proportional to the rate of water flowing.

No. 3608. CONVECTORS: Trane Co., La Crosse, Wis. Elaborate 24 p. bulletin (S-380) available in two editions, one with a French fold cover for presentation by architects, engineers, contractors and builders to preferred clients, and the other with a regular trimmed flush cover punched for binders. Convection heating and the advantages of the manufacturer's convectors are explained and a double page spread illustrates 10 styles and models representative of those available.

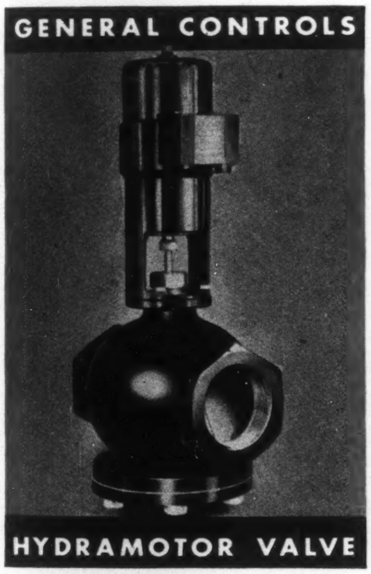
No. 3609. DEHYDRATORS: Carrier Corp., 302 S. Geddes St., Syracuse, N. Y. Data sheet describing self-contained dehydrators used for drying or dehumidifying in both industrial and comfort air conditioning. Silica gel is the adsorber and may be activated by gas or steam.

No. 3610. DIESEL ENGINES: Caterpillar Tractor Co., 600 W. Washington St., Peoria, Ill. 8 p. bulletin on diesel engines, power units, generator sets and marine engines, illustrating the units and giving specifications.

No. 3611. FANS: Chelsea Fan & Blower Co., Inc., 370 W. 15th St., New York, N. Y. Bulletin on "Wind-O-Fan, Junior" for installation in windows of apartments, stores, offices, homes, etc. The fan is rated at 3000 cfm.

No. 3612. FLEXIBLE COUPLINGS: Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill. 12 p. bulletin (1845) on various types of flexible couplings, illustrating and describing them and giving price lists, dimensions and other data. Information on selection and horsepower ratings are included.

GENERAL CONTROLS



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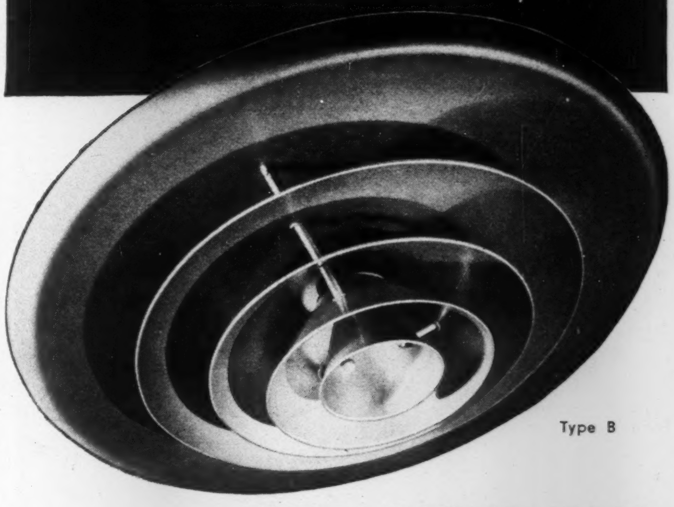

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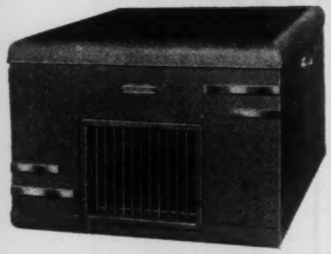

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No. 3613. HEATING BOILERS: Titusville Boiler Div., Struthers Wells-Titusville Corp., Titusville, Pa. 4 p. bulletin (6195) on "Ti-Compact" three pass firebox boilers for coal, oil and gas firing.

No. 3614. HEATING COILS: Fedders Mfg. Co., Inc., 57 Tonawanda St., Buffalo, N. Y. 52 p. catalog (AC-601) on "Type K" heating coils, illustrating and describing in detail their design features, giving dimensions, face areas, external heating surface figures, weights, etc., and presenting extensive tables of final air temperatures and condensation rates for various steam pressures. Curves showing temperature rises for various operating conditions are included, and a number of pages are devoted to pertinent data such as conversion constants, air friction data, piping capacities, and information on selection, application, piping connections and terminology.

No. 3615. INSTRUMENTS AND CONTROLS: Julien P. Friez & Sons, 4 N. Central Ave., Baltimore, Md. 24 p. catalog of instruments and controls for heating, refrigeration and air conditioning, including types for controlling, indicating and recording of humidity, temperature and pressure. The catalog is indexed and each instrument is carefully described and illustrated.

No. 3616. LEATHER PACKINGS: J. E. Rhoads & Sons, 35 N. 6th St., Philadelphia, Pa. Mailing piece describing the advantages of "Tannate" leather packings and illustrating cup leathers, u-leathers, flange leathers and v-leathers.

No. 3617. LUBRICATION OF AIR CONDITIONING EQUIPMENT: Texas Co., 135 E. 42nd St., New York, N. Y. Issue of "Lubrication" (Vol. 26, No. 6), devoted entirely to lubrication of bus and railroad air conditioning equipment. Methods of refrigeration are discussed and careful attention is given to compressor lubrication. Illustrations representing the equipment are included.

No. 3618. ODOR ADSORBERS: Dorex Div., W. B. Con-

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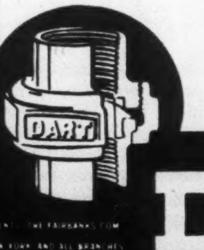

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DART UNIONS
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nor Engineering Corp., 114 E. 32nd St., New York, N. Y. 2 p. bulletin (106) giving description and explaining quick and simple means of figuring sizes, capacities and resistance and showing installation methods. Lower prices on stock sizes of the "Type G" odor adsorbers used in ventilating and air conditioning systems are also announced.

No. 3619. RUBBER DEVELOPMENTS: B. F. Goodrich Co., 548 S. Main St., Akron, Ohio. Booklet reprinting 28 recent advertisements giving typical examples of the manufacturer's developments in rubber, including conveying molasses, coal conveyors, tank linings, etc.

No. 3620. SOLAR HEAT LOAD THROUGH WINDOWS: Ingersoll Steel & Disc Co., 310 S. Michigan Ave., Chicago, Ill. 8 p. engineering bulletin giving data on the reduction of solar load through windows by the use of "Koolshade" sun screen, based on tests made for the manufacturer by Pittsburgh Testing Laboratory. Tables of solar radiation transmitted through single window glass—bare, and through windows with "Koolshade" screens are given in Btu per sq ft per hr, for 30, 35, 40 and 45 deg latitudes. The bulletin discusses the character of the heat gain through the screen, explains the tables and the calculation of heat gain by conduction. A diagram showing solar rays entering through the screen at varying sun elevations is appended.

No. 3621. UNIT HEATERS: McCord Radiator & Mfg. Co., 2587 E. Grand Blvd., Detroit, Mich. 8 p. bulletin on unit heaters describing and illustrating in detail features of construction and tabulating capacities and other engineering data. General information on use of unit heaters is included, as is a rapid method of computing heat losses for buildings. Conversion factors, dimension tables, etc., are appended.

No. 3622. VALVES: Reading-Pratt & Cady Div., American Chain & Cable Co., Inc., Reading, Pa. 16 p. booklet on bar stock valves, containing complete information, dimensions and application recommendations for bronze, carbon, steel and stain-

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ACCURATELY METERS STEAM, WATER, AIR OR GAS

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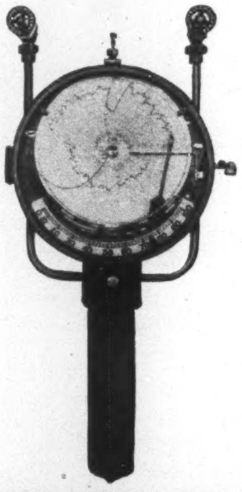

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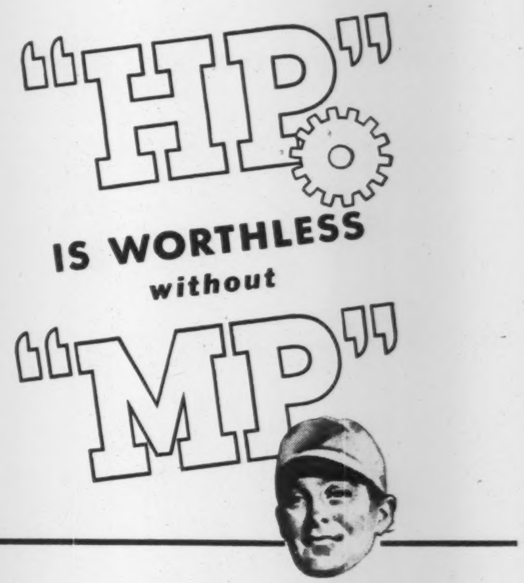

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